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# Biological Aspects and Life Table Parameters of *Phytoseiulus macropilis* and *Neoseiulus californicus* (Acari: Phytoseiidae), Feeding on Eggs And Immature Stages of *Tetranychus urticae* (Acari: Tetranychidae) at Different Temperatures

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## ABSTRACT

The purpose of this study was to evaluate prey consumption, functional response and life table parameters of the two predatory mites on immature stages and eggs of *T. urticae* at two constant temperatures 25° and 30°C, in the laboratory of cotton and crops mite research department, Plant Protection Research Institute Sharkeia branch. Developmental periods (Life cycle) of both females and males individuals were longer for *N. californicus* when fed on immature stages of *T. urticae* at 25°C (7.14 , 5.79 days) for females and males, respectively. Predatory mite fecundity was affected significantly by types of food and high for *P. macropilis* when feeding on *T. urticae* eggs (63.67 eggs/ female) at 25°C; while the less fertility was 33.95 eggs/female for *N. californicus* when fed on *T. urticae eggs* at 30°C. The ability of *N. californicus* preying on immature stages of *T. urticae* was significantly greater than *P. macropilis* (146.24 , 92.29 prey) for female and male, respeclively. On the other hand, *P. macropilis* consumed more eggs than *N. californicus* (193.89, 132.06 prey) for female and male, respectively at 25°C. Life table parameters showed that generation time ($t_G$) was lower (8.81 days) for *P. macropilis* when fed on immature stages of *T. urticae* at 30°C, net reproductive rate ($R_o$) was higher (28.65) for *P. macropils* when fed on eggs at 25°C, and both intrinsic rate of natural increase ($r_m$) (0.34) and finite rate of increase (λ) (1.41) were higher when fed on immature stages of *T. urticae* at 30°C for *P. macropilis.*

***Keywords:*** *Phytoseiulus macropilis; Neoseiulus californicus;Tetranychus urticae;* Biology; life tables; tempertaure.

## INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) is considered one of the most harmful phytophagous mites , which cause more than 25% loss of yield of many plant species in greenhouses, orchards and field crops due to its high rate of fecundity and a short life cycle that may be reached seven days at 32°C in summer (Ebadollahi *et al*., 2015; Kalmosh *et al.*, 2017and Kalmosh, 2018).

The wide spread application of acaricides used for controlling *T. urticae* has a serious and negative impact on the natural balance of the ecosystem, that draw attention for new alternatives for biocontrol (Mansour *et al*., 2004). Phytoseiid mites is an important biological control agent against phytophagous mites and insect pests infesting economic crops due to their high predaceous efficiency and worldwide distribution (Oliveira *et al*., 2009, Khodayari *et al*., 2013, Greco *et al.;* 2005 and Kalmosh *et al*., 2019).

*Neoseiulus californicus* McGregor and *Phytoseiulus macropilis* (Banks) (Acari: Phytoseiidae) are considered two of the most famous predatory mites emerge as natural enemies of *T. urticae* (Ferla *et al*., 2007 and Kalmosh *et al*., 2018). *P. macropilis* presents a low functional response in the presence of low population of prey which hardly staying in the environment for long periods. Contradictory, *N. californicus* is a generalist predator using alternative food sources, fed on more than three species of Tetranychid mites and on *Thrips tabaci* Lindeman shown more flexibility to prey distribution (McMurtry and Croft 1997, Escudero and Ferragut, 2005, Rahmani *et al*., 2009., and Ferla *et al*., 2011).

This work aim to study the effect of food (eggs and immature stages of *T. urticae*) on some biological aspects and life table of *P. macropilis* and *N. californicus*as as a biologicl control agents and determine the most suitable temperature for rearing both mite species.

## MATERIALS AND METHODS

**Tested predatory mite species**

Laboratory stock cultures of the predatory mite species, *P. macropilis* and *N. californicus* were separately maintained on mulberry leaves (*Morus albe* L) with a surplus amount of the two-spotted spider mite *T. uricae* as a prey in laboratory of Acarology at Plant Protection Research Institute (Sharkeia Branch), Sharkeia Governorate, Egypt. Mature virgin females and freshly emerged males of the previous predatory species (which were within 24-48h after the final molt) were left on mulberry leaves and provided with prey mite *T.urticae* until mating occurred.

**Food sources**

The two spotted spider mite, *T. urticae* was reared on kidney bean plants, Phaseolus vulgaris L. planted in greenhouse at Sharkia Governorate. When kidney been plants had 20 days old age, were infested with *T. urticae* collected from leaves of eggplant and then individuals of the *T. urticae* mite moved off the infested leaves to the new

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foliage. *T. urticae* was reared for many generations away from any contamination with acaricides

**Experimental design**

Newly deposited eggs of both predatory mites were transferred singly on a small mulberry leaf approximately 3cm long with its edges lined with a cotton wool as a barrier to prevent predaceous mites from escaping. The leaf was put upside down on a wetted cotton wool pad in a glass petri dish (10 cm in diameter). Moisture was maintained by adding a few drops of water daily and the temperature was kept constant. Each newly hatched larva was supplied with a known number of preys (egg or immature stages) where the consumed preys were removed and replaced with other alive ones daily until the predators reached adulthood. Each experiment was started with at least 30 newly hatched larvae and divided to three groups each 10 newly hatched larvae (Ali, 1998, Ali and El-Laithy 2005 and Rady *et al.*, 2014).

Developing of immature stages from egg to adult were observed three times a day at 8:00 am, 2:00 and 7:00 pm. The duration of developmental stages and female fecundity were also noticed. Observations were made by using a stereoscopic binocular.

**Effect of prey stages on some biological aspects of predaceous mites**

Fertile females of *P. macropilis* and *N. californicus* were transferred singly on mulberry leaf discs (3 cm indiamter) and supplied with sufficient number of preys (eggs or immature stages of *T. urticae*), at 25 and 30°C (El-Taj and Jung, 2012). Durations of different stages were calculated. Adult fecundity, longevity and prey consumption were calculated. The collected data were subject to analyses using one way ANOVA. Differences between means were tested by using Duncan's New Multiple Range test (Duncan, 1955) using CoStat Statistical Software (2005).

**Life table analysis**

Life table parameters were estimated using a BASIC computer program of Abou-Setta *et al.* (1986) for females of *P. macropilis* and *N. californicus* which fed on eggs and immature stages of *T. urticae* at two temperatures (25 and 30 ±2°C) were calculated.

## RESULTS AND DISSCUTION

**Influence of food source on developmental time of two predatory mites**

***T. urticae* immature stages as a food source**

The predacious mites *N. californicus* and *P. macropilis* were successfully completed his life cycle (from egg to adult) when fed on immature stages of *T. urticae* and significsntly affected by temperatures as shown in Table (1).

Incubation period of eggs ranged between 1.51 to 2.54 days at 30°C for *P. macropilis* and *N. californicus*, respectively; while the mean periods of immature stages was lower for *P. macropilis* 2.41 days at 30°C and 4.96 days for *N. californicus* for females at 25°C when fed on immature stages of *T. urticae.*

Female adult longevity was longer for *P. macropilis* (32.16 days) compared with *N. californicus* (28.38 days) when fed on immature stages of *T. urticae* on 25 °C; while adult female longevity of *N. californicus* was elongated to (30.83 days) at 30°C comared *with P. macropilis* (24.95 days). For males longevity there was non significant differences at 25°C but *N. californicus* was longer (27.00 days) than *P. macropilis* (16. 63 days) at 30°C.

Deposited egg of adult females was significantly affected by temperatures and the type of foods, which recorded the higer number of eggs per female when fed on immature stages of *T. urticae* (44.95 eggs) for *P. macropilis* and the lower number was obtained for *N. californicus* 32.5 eggs at 30°C. (Table 1).

***T. urticae* eggs as a food source**

The two predacious mites were successafully completed his life cycle when fed on *T. urticae* eggs.

It was found that immature stages and life cycle were lower for *P. macropilis* than *N. californicus* in both females and males at 30°C. At 25°C the period of immature stages was lower in females of *P.macropils* 2.26 days than in *N. californicus* 3.06 days, and in case of males there were no significant differences at 30°C. As for life cycle, it was less for *P. macropilis* in case of males 4.29 days compared with *N. californicus* 5.32 days, as well as in females it was 4.29 days for *P. macropils* and 5.32days for *N. californicus* at 30°C (Table 2).

As for oviposition period, it was longer for *P. macropilis* and it recorded (35.78 & 29.83 days) compared with (16.33 & 14.74 days) for *N. californicus* at 25°C and 30°C, respectively. Likewise, the total eggs deposited per female was greater for *P. macropilis* (63.67& 45.17 eggs) than *N. californicus* (30.22 & 33.95 eggs) at 25°C and 30°C, respectively. However, the egg daily rate at 25°C for both species were approximately equal, but at 30°C, it was greater for *N. californicus* 2.34 eggs/ day than *P. macropilis* 1.52 eggs/day.The longevity of females and males were longer for *P. macropilis* at (25° C and 30°C) which recorded (45.14 &38.83 days) and (38.82 & 29.79 days) compared with *N. californicus* (27.18 & 28.66 days) & (19.11& 22.83 days), respectively when fed on *T. urticae* eggs.

As well as life span was longer for *P. macropilis* compared with *N. californicus* when fed on *T. urticae* eggs as shown in (Table 2).

The results of the present study were similar to those obtained by Souza *et al*. (2016) they found that the longevity of adult female and male of *P. macropilis* wer 27.5 days and 29.0 days, respectively when fed on *T. urticae*. Ali (1998) evaluated the effect of five different temperatures on the development of *P. macropilis* when fed on eggs of *T. urticae* at 25°C. and found that all developmental stages of *P. macropilis* were high compared to our results. Also, Ali (1998) he stated that the predatory mite *P. macropilis* completed its development and reached adulthood when it fed on *T. urticae* eggs. However, the predator development was not completed when fed with pollen grains of date palm, *Bemaisa tabaci* immatures,*Eutetranychus orientalis* immatures and moving satages of *Cisaberoptus kenyae* at 25°C. El Taj and Jung (2012) found that the fecundity of *N. californicus* was greater when kept at 25°C, whereas daily fecundity was higher at 30°C when fed on the European red spider mite, *Panonychus ulmi*. Also, female and male longevity were decreased with increasing temperature. Longevity of female was much longer than that of male. Ali and El-Laithy (2005) reported that *N. californicus* developmental time was 7.8 days when fed on immature stages of *T. urticae*, but the longest period (13.9 days) was recorded when predatory mite was fed on *T. cucurbitacearum* adults. Similarly, feeding on pollens of date palm and castor bean significantly elongated the life cycle of *N. californicus* females compared with *T. urticae* nymph as a diet (El-Laithy and El- Sawi, 1998).

**Table 1. Duration in days of developmental stages of *N. californicus* and *P. macropilis* fed on *T. urticae* immature stages at different temperatures**

| Predator stages | Sex | Temperature °C | | | | | |
|---|---|---|---|---|---|---|---|
| | | 25° C | | | 30° C | | |
| | | *N. californicus* (No) mean ±SE | *P. macropilis* (No) mean ±SE | $LSD_{.05}$ | *N. californicus* (No) mean ±SE | *P. macropilis* (No) mean ±SE | LSD.05 |
| Egg | ♀ | (22) 2.17±0.06 | (21) 1.96±0.94 | n.s | (22) 2.34±0.09a | (22) 1.51±0.11b | 0.29 |
| | ♂ | (8) 1.78±0.21 | (9)2.06±0.14 | n.s | (7)2.54±014a | (8) 1.59±0.15b | 0.46 |
| Larva | ♀ | (22) 1.20±0.8 | (21) 1.05±0.08 | n.s | (22) 0.78±0.04 | (22) 0.91±0.07 | n.s |
| | ♂ | (8) 1.06±0.11 | (9)1.00±0.06 | n.s | (7)0.82±0.09 | (8)0.97±0.260.0 | n.s |
| Protonymph | ♀ | (21) 1.99±0.12a | (21) 1.29±0.05b | 0.27 | (22) 1.64±0.12a | (22) 0.73±0.07b | 0.26 |
| | ♂ | (7) 1.64±0.13 | (9)1.33±0.13 | n.s | (7)1.36±0.13a | (8) 0.84±0.12b | 0.41 |
| Deutonymph | ♀ | (21) 1.79±0.13 | (21) 1.54±0.13 | n.s | (22) 0.93±0.07 | (22) 0.77±0.07 | n.s |
| | ♂ | (7) 1.36±0.17 | (9)1.39±0.10 | n.s | (7) 0.71±0.08 | (8) 0.88± 0.14 | n.s |
| Total Immatures | ♀ | (21) 4.96±0.17a | (21) 3.87±0.16b | 0.57 | (22) 3.35±0.11a | (22)2.41± 0.09b | 0.28 |
| | ♂ | (7) 4.11±0.27 | (9)3.72±0.12 | n.s | (7)2.89±0.19 | (8)2.69± 0.06 | n.s |
| Life cycle | ♀ | (21) 7.14±0.19 | (21) 5.83±0.19b | 0.64 | (22)5.69± 0.12a | (22)3.92±0.10b | 0.33 |
| | ♂ | (7) 5.79±0.44a | (9) 5.78±0.23 | n.s | (7) 5.43±0.16a | (8) 4.28± 0.17b | 0.53 |
| Pre-Oviposition | ♀ | (21) 1.95±0.12b | (19) 5.82±0.24a | 0.54 | (16)3.33±0.14b | (20)3.95±0.18a | 0.52 |
| Oviposition | ♀ | (21) 17.38±0.74b | (19)20.47±0.38a | 1.78 | (16)15.75±0.61 | (20)15.7±0.38 | n.s |
| Post- Oviposition | ♀ | (21) 9.05±0.49a | (19) 5.87±0.21b | 1.14 | (16)11.75±0.39a | (20)5.3±0.28b | 1.01 |
| Adult longevity | ♀ | (21) 28.38±0.95b | (19)32.16±0.57a | 2.36 | (16)30.83±0.86a | (20) 24.95±0.57b | 2.15 |
| | ♂ | (7)20.71± 0.89 | (9)22.78±0.66 | n.s | (7)27± 0.62 a | (8)16.63± 1.08b | 2.89 |
| Total eggs/female | ♀ | (21) 35.52±0.94b | (19)38.01±0.65a | 2.43 | (16)32.5±0.19b | (20)44.95±0.81a | 2.98 |
| Eggs daily rate | ♀ | (21) 2.17±0.11b | (19) 2.60±0.0a | 0.27 | (16)2.12±0.12b | (20) 2.89±0.53a | 0.31 |
| Life span | ♀ | (21) 36.38±1.25b | (19)52.95±0.79a | 3.15 | (16) 36.66±0.85a | (20) 28.89±0.08b | 2.07 |
| | ♂ | (7)26.5±1.14 | (9)28.56±0.67 | n.s | (7)32.43±0.59a | (8)20.91± 1.11b | 2.94 |

**Table 2. Duration in days of developmental stages of *N. californicus* and *P. macropilis* fed on *T. urticae* eggs at different temperatures**

| Predator stages | Sex | Temperature °C | | | | | $LSD_{.05}$ |
|---|---|---|---|---|---|---|---|
| | | 25° C | | | 30° C | | |
| | | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ± SE | $LSD_{.05}$ | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ±SE | |
| Egg | ♀ | (20)2.04±0.09 | (25) 2.01±0.07 | n.s | (22) 2.23±0.09 | (22) 2.01± 0.08 | n.s |
| | ♂ | (21)1.71±0.07b | (21) 2.02±0.09a | 0.22 | (23)2.09±0.06 | (20) 2.00± 0.09 | n.s |
| Larva | ♀ | (20)1.06±0.07 | (24) 0.93±0.06 | n.s | (22) 0.70±0.04a | (22) 0.55± 0.05b | 0.13 |
| | ♂ | (21)1.00±0.05a | (20) 0.8±0.05b | 0.16 | (23) 0.78±0.04a | (20) 0.56± 0.05b | 0.14 |
| Protonymph | ♀ | (20)1.85±0.11a | (19) 1.00±0.06b | 0.26 | (21) 1.52±0.08a | (21) 0.70± 0.04b | 0.19 |
| | ♂ | (20)1.51±0.04a | (19) 1.01±0.06b | 0.14 | (21) 1.31±0.06a | (20) 0.65± 0.05b | 0.17 |
| Deutonymph | ♀ | (20) 1.64±0.08 | (18) 1.78±0.11 | n.s | (21) 0.85±0.04b | (21) 1.00± 0.05a | 0.13 |
| | ♂ | (20) 1.2±0.05b | (17) 1.38±0.07a | 0.18 | (21)0.64±0.04b | (20) 1.00± 0.06a | 0.14 |
| Total Immatures | ♀ | (20)4.55 ±0.12a | (19)3.57 ±0.15b | 0.51 | (21)3.06± 0.09a | (21)2.26±0.07b | 0.24 |
| | ♂ | (21)3.58±0.07a | (21)2.79±0.11b | 0.26 | (21) 2.74±0.08 | (20) 3.04± 0.08 | n.s |
| Life cycle | ♀ | (20)6.59±0.14a | (19)5.62±0.14b | 0.51 | (21)5.32± 0.13a | (21)4.29±0.13b | 0.37 |
| | ♂ | (21)5.29±0.09 | (21) 4.82±0.15 | n.s | (13) 4.83±0.10a | (19) 4.17± 0.10b | 0.29 |
| Pre-Oviposition | ♀ | (18)1.68±0.07b | (18) 3.44±0.26a | 0.54 | (19) 3.29±0.12a | (18) 3.78±0.26 a | 0.58 |
| Oviposition | ♀ | (18)16.33±0.37b | (18)35.78±0.89a | 1.96 | (19)14.74±0.43b | (18) 29.83± 0.72a | 1.71 |
| Post- Oviposition | ♀ | (18)9.17±0.37a | (18)5.92±0.24b | 0.90 | (19)10.63±0.21a | (18) 5.22± 0.19b | 0.57 |
| Adult Longevity | ♀ | (18)27.18±0.2b | (18)45.14±1.00a | 2.09 | (19)28.66±0.33b | (18)38.83±0.61a | 1.41 |
| | ♂ | (18)19.11±0.6b | (17)38.82±0.35a | 1.49 | (18)22.83±0.6b | (19) 29.79± 0.91a | 2.23 |
| Total eggs/female | ♀ | (18)30.22±0.9b | (18)63.67±0.88a | 1.99 | (19)33.95±0.74b | (18) 45.17±0.90a | 2.39 |
| Daily rate | ♀ | (18)1.85±0.04 | (18)1.79±0.03 | n.s | (19)2.34±0.08a | (18)1.52±0.02b | 0.16 |
| Life span | ♀ | (18)33.74±0.2b | (18)50.92±0.96a | 2.65 | (19)34±0.40b | (18)43.15± 0.64a | 1.53 |
| | ♂ | (18)24.54±0.6b | (17)44.07±0.41a | 1.55 | (18)27.67±0.63b | (19) 33.96±0.93a | 2.27 |

## Prey Consumption

Both predaceous mites *N. californicus* and *P. macropilis* succussefuly completed their developmental stages when feeding on immature stages and eggs of *T. urticae* at 25°C and 30°C. Adult females of *N. californicus* consumed a significantly higher number of immature stages than *P. macropilis* as shown in Table (3). On the other hand, *P. macropilis* was consumed higher number of eggs compared with *N. californicus*. The consumption rate for both predators increased through the developmental stages. The food consumption during the oviposition period was significantly higher than the pre- and post-oviposition periods for both predators.

Females of *N. californicus* consumed average number of *T. urticae* immature stages (110.05 individuals) and that was higher than *P. macropilis* (70.07 individulas) during the oviposition period, during adult longevity it was (146.24 & 128.89 individuals) for *N. californicus* and *P. macropilis*, at 25°C, respectively. While, at 30°C these values averaged (107.5 & 49.4 individuals) for oviposition and (139.88 & 96.6 individuals) for adult longevity of *N. californicus* and *P. macropilis*, respectively. Song e*t al.* (2016) mentioned that the ability of *N. californicus* preying on larvae and nymphs of *Tetranychus* species was significantly greater than *N. longispinosus* at high prey densities, while *N. longispinosus* consumed more prey eggs than *N. californicus*. Also, they noticed that consumption rate of *N. californicus* of *Tetranychus* larvae was highest, followed by the nymphs, and the consumption rate of eggs was the lowest. Kasap & Atlihan (2011) reported that consumption rate of the predators is generally inversely related to prey size. Also, Li *et al.* (2014) compared the consumption rate of larvae, nymphs and eggs of *N. californicus* when feeding on *T. cinnabarinus* at 25°C, the consumption rate of larvae were higher than nymphs and eggs were the lowest.

**Table 3. Food consumption of *N. californicus* and *P. macropilis* fed on *T. urticae* immature stages at different temperatures**

| Predator stages | Sex | Mean No. of devoured prey immatures | | | | | |
|---|---|---|---|---|---|---|---|
| | | 25° C | | | 30° C | | LSD$_{.05}$ |
| | | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ± SE | LSD$_{.05}$ | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ± SE | |
| Larva | ♀ | (22) 2.36±0.43a | (21) 0.00±0.00b | 0.89 | (22) 1.77±0.30a | (22)0.0±0.00b | 0.64 |
| | ♂ | (8) 1.38±0.19a | (9) 0.00±0.00b | 0.38 | (7) 0.71±0.15a | (8) 0.13±0.00b | 0.49 |
| Protonymph | ♀ | (21) 4.38±0.60a | (21) 2.05±0.41b | 1.50 | (22) 3.91±0.75a | (22)1.45±0.21b | 1.62 |
| | ♂ | (7) 3.29±0.20 | (9) 1.78±0.21 | n.s | (7) 2.57±0.21 | (8)1.63±0.44 | n.s |
| Deutonymph | ♀ | (21) 5.95±0.83 | (21) 4.24±0.80 | n.s | (22) 4.91±0.91a | (22)2.77±0.52b | 2.12 |
| | ♂ | (7) 6.14±0.50 | (9) 3.11±0.35 | n.s | (7) 3.57±1.00 | (8) 2.5±0.61 | n.s |
| Total immatures | ♀ | (21) 12.52±1.00a | (21) 6.29±0.82b | 2.56 | (22)10.59±1.11a | (22)4.23±0.92b | 2.70 |
| | ♂ | (7) 10.86±0.48a | (9) 4.89.±0.39b | 4.24 | (7) 6.86±2.22a | (8) 4.25±0.99b | 6.34 |
| Pre-Oviposition | ♀ | (21) 18.95±2.11 | (19)26.37±3.4 | n.s | (16) 16.56±2.78b | (20)17.9±2.13a | 7.21 |
| Oviposition | ♀ | (21)110.05±11.2a | (19)70.05±8.0b | 29.18 | (16) 107.5±9.11a | (20)49.4±6.17b | 23.42 |
| Post- Oviposition | ♀ | (21) 17.24±1.95b | (19)32.47±3.5a | 9.04 | (16) 15.81±2.48b | (20)29.3±3.44a | 9.28 |
| Adult longevity | ♀ | (21)146.24±12.4 | (19)128.89±130 | n.s | (16)139.88±13.8a | (20)96.6±9.86b | 35.52 |
| | ♂ | (7)92.29± 5.17 | (9) 80±4.32 | n.s | (7) 90.29±6.95a | (8)62.38±4.14b | 16.87 |
| Daily rate | ♀ | (21) 5.15 | (19) 4.01 | | (16) 4.54 | (20) 3.87 | |
| | ♂ | (7) 1.28 | (9) 3.51 | | (7) 23.41 | (8) 3.75 | |

The data represented in Table (4) showed that feeding capacity of *N. californicus* and *P. macropilis* were significantly affected by the feeding on eggs of *T. urticae* and the temperatures. The number of devoured preys increased at 25°C and decreased at 30°C for both predators . The total numbers of *T. urticae* eggs consumed by *P. macropilis* averaged 121.00 egg during the oviposition period and adult longevity (193.89 eggs / Female and 132.06 eggs / male) at 25°C. The *P. macropilis* consumed a higher number of *T. urticae* eggs than *N. californicus* during oviposition period (134.11 eggs) and adult longevity (161.11 & 97.89 eggs) for female and male, respectively at 30°C.

The daily consumption rate were (4.67 and 4.29 eggs/day) for adult female of *N. californicus* & *P. macropilis* at 25°C and (4.06 and 4.15 eggs/day) at 30°C; respectively. Ali (1998) found that the feeding capacity of *P. macropilis* was gradually increased by increasing temperature from 20 to 28°C then sharply decreased at 30 and 32°C.

**Influence of food source on life table and reproductive parameters:**

Life table parameters presented in Table (5) mentioned that the shortest mean generation time ($T_G$) of *N. californicus* and *P. macropilis* were 10.35 and 8.81 days at 30°C, when fed on eggs and imatures of *T. urticae*, respectively, while the longest were 13.09 and 15.32 days when fed on immature stages and eggs of *T. urticae* at 25°C, respectively. The highst net reproductive rate ($R_o$) were 23.83 and 28.65 female / female for *P. macropilis* when fed on immature stages and eggs of *T. urticae* at 25°C, respectively.

The intrinsic rate of natural increase ($r_m$) and, subsequently, the finite rate of increase (λ) were relatively higher (0.21 0.24) and (0.21 & 0.26) female/female/day when fed on immature stages and eggs of T. urticae at 25 and 30 °C, respectively, while it recorded (0.26 & 0.34) and (0.22 & 0.26) female/female/day for *P. macropilis* when fed on immature stages and eggs of *T. urticae* at 25 and 30 °C, respectively. The same results recorded by Souza *et al*., 2016 who evaluated the reproduvtive parameters of *P. macropilis* fed on *T.urticae* in laboratory. They found that the longevity of adult female was 27.5 days while of adult male was 29.0 days. The population approximately 27 time (Ro ) in mean generation time ($T_G$), which was 17.7 days. Lastely, the main population grew 1.2 times/day (λ) and double every 3.7 days (TD).

**Table 4. Food consumption of *N. californicus* and *P. macropilis* fed on *T. urticae* eggs at different temperatures**

| Predator stages | Sex | Mean No. of devoured prey eggs | | | | | LSD.05 |
|---|---|---|---|---|---|---|---|
| | | 25° C | | | 30° C | | |
| | | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ± SE | LSD.05 | *N. californicus* (No) mean ± SE | *P. macropilis* (No) mean ±SE | |
| Larva | ♀ | (20)1.65±0.31a | (24) 0.13±0.00b | 0.60 | (22) 1.95±0.36a | (22) 0.00± 0.00b | 0.69 |
| | ♂ | (21)1.76±0.27a | (21) 0.05±0.00b | 0.55 | (23) 2.13±0.31a | (19) 0.00± 0.00b | 0.71 |
| Protonymph | ♀ | (20)3.7±0.73 | (19)3.26 ±0.60 | n.s | (21) 3.59 ±0.67 | (21) 2.86± 0.29 | n.s |
| | ♂ | (20) 2.95±0.39 | (20) 2.55±0.37 | n.s | (21) 2.65±0.36 | (19) 2.21± 0.33 | n.s |
| Deutonymph | ♀ | (20) 4.65±0.88 | (18) 5.5±0.94 | n.s | (21) 4.33±0.77 | (21) 4.43± 0.58 | n.s |
| | ♂ | (19) 4.26±0.55 | (17)3.65±0.52 | n.s | (21)3.86±0.46 | (19) 3.95± 0.66 | n.s |
| Total immatures | ♀ | (20) 10.00±1.30 | (19)8.58±1.23 | n.s | (21)10.00±0.95a | (21) 7.29±0.68b | 2.45 |
| | ♂ | (19)9.16±0.77a | (21)6.35±0.48b | 1.98 | (21) 8.71± 0.63a | (20) 6.16±0.59 b | 1.79 |
| Pre-Oviposition | ♀ | (18)10.33±1.69b | (18)29.39±3.57a | 8.08 | (19)9.95±1.49 | (18) 11.56±1.4 | n.s |
| Oviposition | ♀ | (18)103.06±10.6 | (18)121±12.75 | n.s | (19)93.89±7.01b | (18)134.11±9.55a | 23.82 |
| Post- Oviposition | ♀ | (18)22.78±3.01b | (18)43.5±5.51a | 13.29 | (19)12.58±1.41 | (18) 15.44±2.42 | n.s |
| Adult longevity | ♀ | (18)136.17±11.21b | (18)193.89±13.5a | 38.08 | (19)116.42±11.5b | (18)161.11±10.27a | 31.95 |
| | ♂ | (18) 57.78±6.95b | (17)132.06±9.01a | 23.52 | (18)54.94±6.89b | (19) 97.89± 8.59a | 23.09 |
| Daily rate | ♀ | (18) 4.67 | (18) 4.29 | | (19) 4.06 | (18) 4.15 | |
| | ♂ | (18) 3.02 | (17) 3.17 | | (18) 2.41 | (19) 3.29 | |

**Table 5. Effect of two kind of food and two temperatures on the life table parameters of *N. californicus* and *P. macropilis***

| Predecious mites | Kind of food | Temp. | Parameters | | | |
|---|---|---|---|---|---|---|
| | | | $T_G$ | $R_o$ | $r_m$ | λ |
| *N. californicus* | Immature stages of *T. uticae* | 25±2°C | 13.09 | 16.37 | 0.21 | 1.24 |
| | | 30±2°C | 11.05 | 14.57 | 0.24 | 1.27 |
| | Eggs of *T. uticae* | 25±2°C | 12.43 | 13.6 | 0.21 | 1.23 |
| | | 30±2°C | 10.35 | 15.28 | 0.26 | 1.30 |
| *P. macropilis* | Immature stages of *T. uticae* | 25±2°C | 12.38 | 23.83 | 0.26 | 1.29 |
| | | 30±2°C | 8.81 | 16.37 | 0.34 | 1.41 |
| | Eggs of *T. uticae* | 25±2°C | 15.32 | 28.65 | 0.22 | 1.24 |
| | | 30±2°C | 11.52 | 20.33 | 0.26 | 1.29 |

**(T) = Mean generation time in days, ($R_o$)=Net reproductive rate, ($r_m$)= Intrinsic rate of natural increase per day and (λ) = Finite rate of increase per day.**

**Abbreviations**

SE: Stander error; LSD: Least Significant Difference; Tc: Mean generation time in days; Ro: Net reproductive rate; rm: Intrinsic rate of natural increase per day; λ: Finite rate of increase per day.

## CONCLUSION

Both species *N. californicus* and *P. macropilis* completed their life cycles in an adequate way feeding exclusively on *T. urticae* immature stages and eggs but *T. urticae* eggs as a food source was prefered to *P. macropilis* than immature stages of spider mite at 25°C and this temperature increased the adult female fecundity.

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## النواحي البيولوجية وجداول الحياة للمفترسين الأكاروسين *Phytoseiulus macropilis* و *Neoseiulus californicus* (أكاري: فيتوسيد) عند تغذيتهم علي البيض والأطوار الغير كامله لـ *Tetranychus urticae* (أكاري: تترانيكيد) تحت درجات حرارة مختلفة


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وقد أجريت هذه التجارب لدراسة معدل الاستهلاك للفرائس والاستجابة الوظيفية وجداول الحياة للمفترسين الأكاروسين عند التغذية علي المراحل غير الناضجة والبيض للنوع *T. urticae* عند درجتي حرارة 25 و 30 درجة مئوية ، في معمل أكاروس القطن والمحاصيل بمعهد بحوث وقاية النباتات- فرع الشرقية. وكانت فترات النمو (دورة الحياة) لكلا من الإناث والذكور أطول للنوع *N. californicus* عند التغذية علي الأطوار الغير ناضجة لـ *T. urticae* عند درجة 25 درجة مئوية (7.14، 5.79 يوم للإناث والذكور علي التوالي). وقد تأثرت خصوبة المفترس إحصائيا بإختلاف أنواع التغذية وكذلك درجة الحرارة، فقد سجل أعلي معدل خصوبة للنوع *P. macropilis* وقد سجل 63.67 بيضة/ أنثي عند 25 درجة مئوية بينما كانت نسبة الخصوبة أقل 33.95 بيضة / أنثي للـ *N. californicus* عند درجة 30 درجة مئوية عند تغذيتهم علي بيض *T. urticae*. وكانت قدرة النوع *N. californicus* علي الإفتراس علي المراحل الغير كاملة للـ *T. urticae* أكبر بكثير من النوع *P. macropilis* (92.29 ، 146.24 فريسة للإناث والذكور علي التوالي). ومن ناحية أخري فقد استهلك النوع *P. macropilis* بيضا أكثر عن النوع *N. californicus* (132.06، 193.89 بيضة للإناث والذكور علي التوالي) عند درجة 25 درجة مئوية. وعند دراسة جداول الحياة فقد وجد أن معدل مدة الجيل ( $T_G$ ) كان أقل 8.81 يوما للنوع *P. macropilis* عند التغذية علي المراحل غير الكامله للـ *T. urticae* عند درجة 30 درجة مئوية، وكان كلا من معدل الزيادة الذاتي ($r_m$) (0.34) ومعدل الزيادة المحدودة($\lambda$) (1.41) أعلي عند التغذية علي المراحل الغير كاملة للـ *T. urticae* عند درجة 30 درجة مئوية للمفترس الأكاروسي *P. macropilis*.