

Possibility of Utilizing *Neoseiulus californicus* (McGregor) (Acari: Phytoseiidae) to Control *Oxyacarus niloticus* Zaher and Abou-Awad (Acari: Eriophyidae)

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ABSTRACT

The life history and predation rate of the predatory mite, *Neoseiulus californicus* (McGregor) on the olive mite, *Oxyacarus niloticus* Zaher and Abou-Awad and *Tetranychus urticae* Koch, were separately studied at 25°C and 60–70% R.H. *O. niloticus* was collected from the upper surface of olive leaves *Olea europaea* L. and the two-spotted spider mite, *T. urticae* from castor oil plant *Ricinus communis*. All movable stages of the predator were able to devour *O. niloticus* more than *T. urticae* adult female. Predation rate, life cycle, and oviposition periods varied depending on type of prey. Predator larva, protonymph, deutonymph and adult female and male consumed 1.2, 6.8, 7.9, 11.7 and 10.1 of *O. niloticus* adults or 0.1, 1.9, 2.8, 3.6 and 3.1 of *T. urticae* adults per day, respectively. Nevertheless, the intrinsic rate of natural increase (r_m) was lower on *O. niloticus* than on *T. urticae*, 0.158 and 0.210, respectively. Results indicated the effectiveness of *N. californicus* as an important biological control agent against *O. niloticus*.

Key Words: *Neoseiulus californicus*, Development, Life table, Predation, *Oxyacarus niloticus*, *Tetranychus urticae*.

INTRODUCTION

Many eriophyid species are of certain economic importance as typical pests of perennial and annual plants (Lindquist, 1996). Over 3000 eriophyid species assigned to nearly 300 genera, are known in the world fauna (Amrine 1996 and Lindquist & Amrine 1996). Members of the eriophyid and diptilomiopid families live on trees, shrubs, and herbaceous plants (Zaher, 1984). Numbers of *Oxyacarus niloticus* are normally found on the upper surface of terminal olive leaves and produce some leaf pitting and deformation of buds as well as leaves.

González *et al.*, 2000 reported that populations of the phytoseiid mites *Neoseiulus californicus* and *Typhlodromus* sp. were associated with the colonies of eriophyids on olive trees. The former is considered the most efficient predator of tetranychid mites.

N. californicus appears to act as a generalist tetranychid predator and can initiate multiple attacking behaviors. On the other hand, its behavior suggests that it is opportunistic and capable of capturing several different types of prey (Takano-Lee and Hoddle, 2002). It feeds successfully on eriophyid mites as it quickly accepts *A. lycopersicus* prey. Predator female devoured 23.89 eriophyid adults, (Castagnoli *et al.*, 2003).

The current study aims to investigate the possibility of *Neoseiulus californicus* to predate on *Oxyacarus niloticus* under laboratory conditions. Biological parameters were used to evaluate the performance of this phytoseiid on olive for

controlling *O. niloticus*.

MATERIALS AND METHODS

Life history characteristics and predation of *N. californicus* on the eriophyid *O. niloticus* and the tetranychid *T. urticae* were conducted in the laboratory at 25 ± 2°C and 70 ± 5% R.H. The eriophyid mite, *O. niloticus* was collected from the upper surface of olive leaves *Olea europaea* L. and the two spotted spider mite from the lower surface of castor oil plant *Ricinus communis* leaves. Petri dishes as rearing units were coated on its lower surface and sides with a layer of moist cotton wool and put upside down in large plate's full with water to provide moisture continuously. Five small discs of mulberry leaves, *Morus alba* L. (about 2.5 cm diameter), were put upside down on the moist cotton. Five Petri dishes were assigned for rearing *T. urticae* and others for rearing *O. niloticus*.

A layer of wet cotton was placed around each leaf disc as barrier to confine the predator to a definite area. One egg of *N. californicus* was put on each disc for development to the adult stage and observed twice daily. When the *N. californicus* larvae hatched, a certain number of *T. urticae* adult females were placed on each disc or a small piece of olive with known number of *O. niloticus* was placed on each disc. Thus, one *N. californicus* larva was liberated on each disc, and the numbers of preys eaten during its larval, protonymphal, deutonymphal stages and adult female or male were recorded. Surplus food was provided whenever the supply became low or the olive leaves needed to be changed.

Female survival and reproduction:

The fecundity of *N. californicus* was determined at 25°C. Before the final molt of the female deutonymph, one adult male was provided and was ensured to mate once. The male was then removed and observations were made twice a day until the first egg was laid. Thereafter, the number of laid eggs was recorded every 24 hours until the female died. All resulting hatched larvae were transferred to new excised mulberry leaves and reared until adult stage to record the sex ratio of resultant progeny. Oviposition, pre-and post-oviposition periods were also recorded. The intrinsic rate of natural increase (r_m) at 25°C was estimated according to the equation given by Birch (1948). The following life history parameters; net reproductive rate (Ro), mean generation time (T), and finite rate of increase (λ) were determined after Hulting *et al.* 1990. Longevity and fecundity data were analysed with Mann-Whitney U-test or Kruskal-Wallis test.

RESULTS AND DISCUSSION

The daily average number of *T. urticae* adult females and *O. niloticus* as prey consumed by developmental stages of *N. californicus* was listed in table 1. The daily average preyed adult females of *T. urticae* by larva, protonymph, deutonymph and adult female and male were 0.1 ± 0.32 , 1.9 ± 0.90 , 2.8 ± 0.74 , 3.6 ± 0.86 and 3.1 ± 0.86 , respectively. The developmental stages of *N. californicus* accepted *O. niloticus* as prey by high consumption rate. The daily average of *O. niloticus* stages consumed by predator larva, protonymph, deutonymph, and adult female and male were 1.2 ± 0.8 , 6.8 ± 3.6 , 7.9 ± 3.4 , 11.7 ± 9.2 and 10.0 ± 8.4 , respectively.

The estimated values of life table parameters for *N. californicus* are listed in table 2. The mean generation time (T, in days) of *N. californicus* was 17.7 and 13.7 when the prey was *T. urticae* or *O. niloticus*, respectively. The net reproductive rate (Ro) was higher on *T. urticae* as prey than on *O. niloticus*, which was 23.21 and 17.46, respectively. The intrinsic rate of natural increase (r_m) was higher on *T. urticae* than on *O. niloticus*, which was 0.210 and 0.158, respectively. Also, the finite rate of increase (λ) was higher on *T. urticae* as prey than on *O. niloticus*, being 1.24 and 1.17, respectively. However, the sex ratio (female: male) was slightly lower in *T. urticae* as prey than in *O. niloticus* which was 2.0:1 and 2.1:0.9, respectively.

The duration and rate of reproduction of *N. californicus* are shown on table 3. The pre-oviposition, oviposition, postoviposition periods,

total no. of eggs/female, average no. of eggs/female/day and adult longevity with *T. urticae* as prey were 1.59, 17.44, 11.23, 32.36, 1.86 and 29.76, respectively. These values decreased when using *O. niloticus* to 1.39, 11.35, 8.84, 19.64, 1.73 and 21.08, respectively.

From the previous results, it could be noticed that, the all developmental stages of *N. californicus* predated on *O. niloticus* more than *T. urticae* as prey. Also, the predator adult female consumed more prey than other development stages.

Present result as other previous studies indicated that *N. californicus* can play a good role in the control of *O. niloticus*, as it was able to quickly recognize, attack and kill the prey and to utilize it as food in order to increase its population (Castagnoli *et al.*, 2003), and can reduce its population densities as a generalist predator (Mc Murtry and Rodriguez 1987; Mc Murtry and Croft 1997 and Croft *et al.*, 1998). This species (*N. californicus*) can survive and reproduce on different mite and insect species and pollens (Castagnoli and Falchini, 1993; Sabelis and Van Rijn, 1997 and Croft *et al.*, 1998).

However results may be promising of utilizing *N. californicus* in the biological control of *O. niloticus*; with depend on the ability of the predator to adapt to olive tree as host plant. This needs further studies to establish such adaptation.

The intrinsic rate of natural increase (r_m) is one of the criteria that are extensively used in evaluating the efficacy of many predatory mites against spider mites (Tanigoshi 1982; Sabelis 1985a). Our results revealed that at 25°C, the r_m value obtained from *N. californicus* fed solely on adult females of *T. urticae* was 0.210, higher than that obtained with feeding on adults of *O. niloticus* which was 0.158. Gotoh *et al.* 2004 reported an r_m value of 0.274 at 25°C for the Japanese strain fed solely on eggs of *T. urticae*. Although the daily consumption rate of adult female of *T. urticae* was lower than for *O. niloticus* by *N. californicus*, but the high rate of daily consumption of *O. niloticus* was offset by lower intrinsic rate of natural increase r_m value. Our result indicated that *T. urticae* was the suitable prey mite for mass-rearing where *N. californicus* was capable to achieve higher r_m . This is the most common functional response of the phytoseiid species to an increasing density of spider mites (Sabelis, 1985b). Also our study indicated that *N. californicus* had experienced an alternative mass rearing diet. It showed ability to adapt rapidly on selective prey (Castagnoli and Simoni, 1999). It is known that a wild predator strain needs several generations to utilize a new food

Table (1): Daily average adult females of *T. urticae* (T. u) adults and *O. niloticus* (O.n) consumed by *N. californicus* developmental stages at $25 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H.

Predator stage	T.u \pm SD	O.n \pm SD
Larva	0.1 \pm 0.32	1.2 \pm 0.8
Protonymph	1.9 \pm 0.90	6.8 \pm 3.6
Deutonymph	2.8 \pm 0.74	7.9 \pm 3.4
Female	3.6 \pm 0.86	11.7 \pm 9.2
Male	3.1 \pm 0.86	10.0 \pm 8.4
T. u. <i>T. urticae</i>	O. n. <i>O. niloticus</i>	

Table (3): Duration in days and egg production of *N. californicus* adult females when reared on different preys; adult females of *T. urticae* (T.u) and *O. niloticus* stages; at $25 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H.

Parameter	T.u	O.n
Preoviposition period	1.59	1.39
Oviposition period	17.44	11.35
Postoviposition period	11.23	8.84
Total no. of eggs/female	32.36	19.64
Average no. of eggs/female/day	1.86	1.73
Total adult longevity	29.76	21.08

Table (2): Life table parameters of *N. californicus* reared on *T. urticae* (T.u) and *O. niloticus* (O.n), adult females at $25 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H.

Prey	Mean generation time (T, days)	Net reproductive rate (R ₀)	Intrinsic rate of natural increase (r _m /day)	Finite rate of increase (λ)	Sex ratio (F:M) ^a
T. u ^b	17.7	23.21	0.210	1.24	2.0:1
O. n ^c	13.7	17.46	0.158	1.17	2.1:0.9

^aFemale and male proportion

^b*T. urticae*

^c*O. niloticus*

source for development and reproduction efficiently (Castagnoli and Liguori, 1994; Castagnoli *et al.*, 1996). Therefore, it can be concluded that improving of intrinsic rate of natural increase, r_m values can be obtained by rearing *N. californicus* on *O. niloticus* with several generations. This could be improved naturally, when the eggs of *O. niloticus* are available on the olive leaves by high rate during applying the biological control program.

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