

**POSSIBILITY OF UTILIZING THE PREDATORY MITE,
NEOSEIULUS CALIFORNICUS (MCGREGOR) (ACARI:
PHYTOSEIIDAE) FOR CONTROLLING TWO ERIOPHYOID FIG
MITES, *ACERIA FICUS* (COTTE) AND *RHYNCAPHYTOPTUS
FICIFOLIAE* KEIFER (ACARI: ERIOPHYIDEA)**

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ABSTRACT: *The life history and predation rate of the predatory mite, Neoseiulus californicus (McGregor) on fig bud mite, Aceria ficus (Cotte) and fig leaf mite, Rhyncaphytoptus ficifoliae Keifer, were studied separately at 25°C and 60–70% R.H. The predatory mite completed its life span when fed on the mentioned mites. The predation rate, life cycle, and oviposition periods varied depending on type of prey. The development was quickest and number of prey consumed was highest when individuals were maintained on A. ficus, compared with R. ficifoliae. The sex ratio (female: male) was slightly lower on A. ficus as prey than on R. ficifoliae where it was 2.0:1 and 2.1:0.9, respectively. The average number of eggs/female/day was 2.98 and 1.67 with total average 37.2 and 23.2 egg on fig bud and fig leaf mites, respectively. The total average of prey consumed by predatory mite were 265.7 & 239.3 and 236.4 & 211 individual for female and male when fed movable stages of A. ficus and R. ficifoliae , respectively.*

Key words: *Neoseiulus californicus, Development, Life span, Predation, Aceria ficus, Rhyncaphytoptus ficifoliae.*

INTRODUCTION

The fig is one of the oldest deciduous fruit that attacked by many pests. In Egypt, three injurious mites were commonly found on the fig trees: fig bud mite *Aceria ficus* (Cotte), fig leaf mite *Rhyncaphytoptus ficifoliae* Keifer, and the two-spotted spider mite *Tetranychus urticae* Koch. The most familiar symptoms caused by these mites are rusting or surface browning, bud blasting, impedance of new growth, bud distortion and leaf chlorosis. Severe infestation may result in defoliation of branches or whole trees (Abd-Elkhalek, 1993; Abou-Awad *et al.*, 1999). In addition, The eriophyid mite *A. ficus* is one of the most important and injurious species in the family Eriophyidae, because it is not only damages fig trees by feeding but it is also a vector of fig mosaic virus disease (Abou-Awad *et al* 1999; Halawa,2003). The long-

term use of certain pesticides in chemical programs in Egypt may be partially responsible for the increase of injurious mite numbers on cultivated crops. These adverse changes can be minimized by delaying application to allow native bio-control agents to have an affect (Abou-Awad *et al* 1999). The predacious mites from family Phytoseiidae Berlese and Stigmaeidae Oudemans are documented for controlling eriophyoid and tetranychid mites by several authors (Zaher & Elbadry, 1961; Schuster & Pritchard, 1963; McMurtry *et al.*, 1970; Solomon, 1975; Rice *et al.*, 1976; Yousef *et al.*, 1982; Abou- Awad, 1983; El-Bagoury & Reda, 1985; Kroperynska & Tuovinen, 1988; Amano & Chant, 1990; Abou-Awad & El-Sawi, 1993). Accordingly, the predacious mite, *Neoseiulus californicus* (McGregor) appears to act as a generalist predator against tetranychid mites and can initiate

multiple attacking behaviors. On the other hand, the behavior of *N. californicus* suggests that, it is opportunistic and capable of capturing several different types of prey (Takano-Lee and Hoddle, 2002). It feeds successfully on species of eriophyid mites as it quickly accepts *Oxycenus niloticus* (Zaher and Abou-Awad) and *Aculops lycopersici* (Masse) as preys. (Ebrahim *et al*, 2013). The current study aims to investigate the possibility of *Neoseiulus californicus* to complete its life- span when fed on individuals of the fig bud mite, *A. ficus*, and fig leaf mite, *R. ficifoliae*.

MATERIALS AND METHODS

Life history characteristics and predation of *N. californicus* on the eriophyid mites *A. ficus* and *R. ficifoliae* were conducted in the laboratory at 25 °C and 70 ± 5% R.H. The eriophyid mites were collected from the lower surface of ficus leaves *Ficus carica* L. Petri dishes as rearing units were coated on its lower surface with a layer of moist cotton wool and put in big Petri dishes full with water to provide moisture continuously. Five small pieces discs of ficus leaves (about 2.5 cm diameter), were put upside down on the moist cotton. 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 moving stage and was observed twice daily. When the *N. californicus* larvae hatched, a small piece of ficus leaves with counted number of *A. ficus* and *R. ficifoliae* were placed on each disc assigned for *A. ficus* or *R. ficifoliae*. Thus, one *N. californicus* larva was liberated on each disc, and the numbers of prey eaten during its larval, protonymphal, deutonymphal and adult female or male were recorded. Surplus food was provided whenever the supply became low or the ficus leaves need to change . 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 at intervals twice a day until the first egg was laid. Thereafter, the number of laid eggs was recorded every 24 hours until the ovipositing female died. All resulting hatched larvae were transferred to new excised ficus leaves and reared until adult stage to record the sex ratio of resultant progeny. Oviposition, pre-and post-oviposition periods were also recorded.

Statistical analysis: One way ANOVA was calculated by using SPSS program. In addition, LSD (Fisher's Significant Difference Test) was chosen to identify the significant difference.

RESULTS

The predatory mite *N. californicus* was succeed to complete its life cycle on two different species of eriophyid mites at similar condition 25 °C and 70 ± 5% R.H. The developmental time for male and female of *N. californicus* reared on two eriophyid mites (*A. ficus* or *R. ficifoliae*) are recorded in Table (1). The adult females of predacious mite were needed 12.22 day to develop from egg to adult when fed *A. ficus* while, it required 13.1 day to develop from egg to adult when fed on *R. ficifoliae* with significant difference (0.257). Under similar conditions, the duration of different stages of *N. californicus* were affected by type of prey where the incubation period; larval stage ,protonymph; deutonymph of female were required shortest time when fed on *A. ficus* (4.35; 2.38; 2.55; 2.94 day, respectively with total immature time 7.87 day) while the duration of egg; larva; protonymph; deutonymph required (4.35; 2.75; 2.97; 3.03 day, respectively with total immature time 8.75) when fed on *R. ficifoliae* Table (1). Significant difference (0.1913) was found between total immature time for females of *N. californicus* when fed on *A. ficus* and *R. ficifoliae* . Similar trend was recorded on the duration of life cycle for males of *N. californicus* (11.69 and 12.67 day) when fed on movable stages of *A. ficus* and *R. ficifoliae* with high significant difference

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(0.3367). The different stages of life cycle (egg, larva, protonymph, deutonymph) for males were required shorter time (4.05; 2.22; 2.48; 2.93 day, respectively, with total immature 7.64 day) when fed on *A. ficus* than *R. ficifoliae* where the different stages of life cycle required (4.1; 2.73; 2.94; 2.95 day, respectively with total immature 8.62

day), therefore highly significant difference(0.3165)was found between the duration of life cycle for males of *N. californicus* depending on type of prey. The generation time also was affected by type of prey where it was 13.65 day and 14.79 day when fed on *A. ficus* and *R. ficifoliae*, respectively ,Table (2).

Table (1): Average duration of the immature stages of *N. californicus* when fed on eriophyoid mites *A. ficus* and *R. ficifoliae* at 25 ± 2°C and 70 ± 5% R.H.

Developmental stages	<i>A. ficus</i> Mean± S.D		<i>R. ficifoliae</i> Mean± S.D	
	Female	Male	Female	Male
Incubation period	4.35± 0.24 ^a	4.05±0.12 ^b	4.35± 0.24 ^a	4.1±0.12 ^b
Larva	2.38± 0.10 ^a	2.22±0.09 ^c	2.75±0.10 ^b	2.73±0.12 ^d
Protonymph	2.55±0.10 ^a	2.48±0.02 ^c	2.97±0.09 ^b	2.94±0.008 ^d
Deutonymph	2.94±0.10 ^a	2.93±0.02 ^c	3.03±0.11 ^a	2.95±0.03 ^c
Total immature	7.87±0.20 ^a	7.64±0.08 ^c	8.75±0.20 ^b	8.62±0.03 ^d
Life cycle	12.22±0.29 ^a	11.69±0.15 ^c	13.1±0.24 ^b	12.67±0.12 ^d

Different letters (a and b between females while c and d for males) in horizontal column denote significant difference .

Table (2): Average duration of various adult periods, generation, of *N. californicus* and number of eggs laid by the adult females when fed on eriophyoid mites *A. ficus* and *R. ficifoliae* at 25 ± 2°C and 70 ± 5% R.H.

Predator stage	<i>A. ficus</i> Mean± S.D		<i>R. ficifoliae</i> Mean± S.D	
	Female	Male	Female	Male
Pre-oviposition	1.43±0.08 ^a	-	1.69±0.09 ^b	-
Generation	13.65±0.29 ^a	-	14.79±0.20 ^b	-
Oviposition	12.44±0.17 ^a	-	13.85±0.18 ^b	-
Post-oviposition	7.07 ±0.16 ^a	-	6.21±0.21 ^b	-
Adult longevity	20.94±0.24 ^a	19.8±0.18 ^c	21.75±0.16 ^b	17.22±0.34 ^d
Life span	33.16±0.40 ^a	31.4±0.4 ^c	34.86±0.31 ^b	29.8±0.40 ^d
No. of eggs/female	37.2±1.26 ^a	-	23.3±1.94 ^b	-
No. of eggs/female/day	2.98±0.14 ^a	-	1.67±0.13 ^b	-
Sex ratio (female: male)	2.3: 0.7	-	2.1 :0.9	-

Different letters (a and b between females while c and d for males) in horizontal column denote significant difference .

The average duration of longevity for females and males were recorded in Table (2) where they were 20.94 & 21.75 day and 19.8 & 17.22 day for females and males when fed on *A. ficus* and *R. ficifoliae*, respectively. The oviposition period was the longest (13.85 day) when the predator mite *N. californicus* fed on *R. ficifoliae*, while it was 12.44 day when fed on *A. ficus*. The adult female was lived after stopped laying egg for 7.07 and 6.21 day when fed on *A. ficus* and *R. ficifoliae*, respectively. Therefore, the time of life span was affected by type of prey where it was 33.16 & 34.86 day for females and 31.4 & 29.8 day for males when fed on *A. ficus* and *R. ficifoliae*, respectively. In addition, significant differences were found between females (0.3364) and between males (0.5162) depending on type of prey. Female oviposited 37.2 and 23.3 eggs, with a daily rate of 2.98 and 1.67 eggs on the *A. ficus* and *R. ficifoliae*, respectively. Significant difference (0.1383) was found between the two prey species. However, the sex ratio (female : male) was slightly lower on *A. ficus* as prey than on *R. ficifoliae* where it was 2.0:1 and 2.1:0.9, respectively.

Food consumption:

Data in Table (3) shows the numbers of both eriophyoid prey consumed by different stages of predacious mite. The larval stage of female was consumed 3.5 individual from each prey *A. ficus* and *R. ficifoliae* while, the larval stage of male was consumed 2.75 and 2.4 individual of *A. ficus* and *R. ficifoliae*, respectively. In addition, the protonymphal stage of female was devoured 18.8 & 16.5 individual of *A. ficus* and *R. ficifoliae*, respectively while, the protonymphal stage of males was devoured 16.5 individuals from each prey. The consumption rate was increased in deutonymphal stage for males and females where the total average of consumption were 25.1 & 24.3 individuals and 22.5 & 20.4 individuals for females and males from *A. ficus* and *R. ficifoliae*, respectively. The females through oviposition

period were very active of feeding where a total average of consumed prey were 142.4 and 125.2 individuals of *A. ficus* and *R. ficifoliae*, respectively. Moreover, the consumption rate for adult female was decreased after stopped of egg laying, where the total average of consumed prey was 60.3 & 52.8 individuals of *A. ficus* and *R. ficifoliae*, respectively. On the other hand, the adult males were less than females in food consumption, the consumption rates of males of predator mite *N. californicus* were 179.5 & 172 individuals while the consumption rates of females were 218.3 & 191.6 individuals of *A. ficus* and *R. ficifoliae*, respectively. Females consumed 265.7 individual of *A. ficus* and 236.4 individual of *R. ficifoliae* during life span while males consumed 239.3 individual of *A. ficus* and 211 individual of *R. ficifoliae*. Thus, the mentioned data showing a preference for the fig bud mite *A. ficus* with .

DISCUSSION AND CONCLUSION

Like many phytoseiids, *N. californicus* has a wide range of host preys i.e. tetranychoids, eriophyids, insects and pollen grains (Swirski *et al.*, 1967; Metwally *et al.*, 1984; El-laithy & Fouly, 1992; Momen & El-Sawi, 1993; Abou-Awad *et al.*, 1999). In the present study, *N. californicus* developed successfully from larva to adult when fed on eriophyoid fig mites *A. ficus* and *R. ficifoliae*. Development was faster and reproduction was higher when fed on *A. ficus*. Development was more rapid for males than for females, this might be advantageous for successful mating (Amano & Chant, 1977). Adults were able to mate immediately after the final moult. The rapid development of predacious mites has commonly been accepted by Acarologists as being advantageous for the control of pest mites in the field. At the same time, the superiority of prey species as food for the most phytoseiid mites has also been judged by the short developmental times of the phytoseiid feeding on them (Amano & Chant, 1986,

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Abou-Awad *et al*, 1999), as mentioned that, the larval stages of the predatory mite, *Amblyseius swirskii* Athias-Henriot did not feed on eriophyid prey while this study agree with Schausberger & Croft, (2014) they mentioned that, the larvae of *N. fallacis* (Garman), *N. californicus*, and *Amblyseius andersoni* Chant are facultative feeders. However, Abou-Awad (1983) mentioned above reported that the larval feeding in phytoseiids depends on the species studied. Many published literature reveals some different data under similar conditions, Ebrahim *et al* (2013) recorded that the adult females of *N. californicus* lived an average of 12.08 and 29.76 day and laid only 1.73, and 1.86 eggs/day when fed on eriophyid mite *Oxycenus niloticus* Zaher and Abou-Awad and *Tetranychus urticae* Koch respectively. In this study, females lived for 20.94 and 21.75 days, while ovipositing 2.98 and 1.67 eggs/day when fed on the fig bud and fig leaf mites, *A. ficus* and *R. ficifoliae*, respectively. The fecundity of predacious mite *N. californicus* when fed on fig bud mite, *A. ficus* was higher than previously recorded on tetranychoids and eriophyids.

Other studies showed several phytoseiid mites to be major predators of eriophyids: *N. californicus*, *Amblyseius fallacies* Garmen, *Typhlodromus rickeri* Chant, *Phytoseius finitimus* Ribaga, *Amblyseius olivi* Nasr & Abou-Awad, *Amblyseius finlandicus* (Oudemans) and *A. andersoni* (McMurtry & Scriven, 1964; EL-Banhawy, 1974, Abou-Awad & EL-Banhawy, 1986; Duso & Camporese, 1991).The females and males of the predatory mites, *N. californicus* consumed an average total of 218.3, 197.5 *A. ficus* or 191.6, 172.0 *R. ficifoliae* during the adult stage .The current study showing a preference for the fig bud mite, *A. ficus* . Abou- Awad *et al.*(1999) and Sabelis (1981) reported that the prey consumption consisted of a ratio of about 70% of the biomass of deposited eggs. The total eggs deposited during oviposition period represented about 70% from total protein of prey. Finally, The present result as other previous studies indicated that *N. californicus* can play a good role in the control of eriophyid fig mites, *A. ficus* and *R. ficifoliae* .

Table (3): Number of prey consumed by different postembryonic stages of *N. californicus* fed on eriophyoid mites *A. ficus* and *R. ficifoliae* at 25 ± 2°C and 70 ± 5% R.H.

Predator stages	<i>A. ficus</i> Mean± S.D		<i>R. ficifoliae</i> Mean± S.D	
	Female	Male	Female	Male
Larva	3.5±0.70 ^a	2.75±0.5 ^c	3.5±0.7 ^a	2.4 ±0.5 ^d
Protonymph	18.8±1.3 ^a	16.5±0.6 ^c	16.5±1.0 ^b	16.5±0.5 ^c
Deutonymph	25.1±0.8 ^a	22.5±0.6 ^c	24.30±1.1 ^a	20.4±1.5 ^d
Total immature	47.4±2.0 ^a	41.8±0.5 ^c	44.80±1.9 ^b	39.4±1.8 ^d
Pre-oviposition	15.4±1.2 ^b	-	13.6±0.52 ^a	
Oviposition	142.6±2.3 ^a	-	125.2±2.3 ^b	
Post-oviposition	60.3±1.95 ^a	-	52.8±2.4 ^b	
Adult longevity	218.3±3.78 ^a	197.5±2.4 ^c	191.6±3.2 ^b	172±2.9 ^d
Life span	265.7±6.7 ^a	239.3±2.1 ^c	236.4±5.1 ^b	211±4.0 ^d

Different letters (a and b between mean total of prey consumed by females while c and d for mean total of prey consumed by males) in horizontal column denote significant difference .

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إمكانية إستخدام المفترس الاكاروسى *Neoseiulus californicus* (McGregor)
لمكافحة حلم براعم وأوراق التين الدودى (Acari: Phytoseiidae)
Aceria ficus (Cotte) & *Rhyncaphytoptus ficifoliae* Keifer (Acari:
Eriophyoidea)

علاء محمد حلاوه

قسم بحوث اكاروس الفاكهة - معهد بحوث وقاية النباتات - مركز البحوث الزراعية

المخلص العربى

تمت دراسة تاريخ الحياة ومعدل الافتراس للمفترسى الاكاروسى *Neoseiulus californicus* (McGregor) عند تغذيته على نوعين من الحلم الدودى على التين وهما حلم براعم التين وحلم اوراق التين *Aceria ficus* (Cotte), *Rhyncaphytoptus ficifoliae* Keifer تحت الظروف المعملية على درجة حرارة 25 م° ورطوبة نسبية 70 %.

اثبتت الدراسة نجاح المفترس فى استكمال دورة حياته عند تغذيته على الاكاروسات المذكورة كما اثبتت الدراسة ان معدل الافتراس , دورة الحياة , فترة وضع البيض اختلفت باختلاف نوع الفريسة حيث كان معدل التطور اسرع ومعدل الافتراس اعلى عند تغذية المفترس على اكاروس براعم التين *Aceria ficus* حيث متوسط معدل الافتراس 265,7 & 239,3 و 236,4 & 211 فرد للاناث والذكور عند تغذيته على اكاروس براعم التين و اكاروس اوراق التين على التوالي بينما كان المعدل اليومى للانثى فى وضع البيض 2,98 و 1,67 بمتوسط كلى 2'37 و 23,2 بيضة عند تغذية اكاروس براعم التين و اكاروس اوراق التين على التوالي .

Possibility of utilizing the predatory mite, neoseiulus californicus

