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Comparative Biology of *Tetranychus urticae* Koch (Acari: Tetranychidae) on Three Solanaceous Plants and the Predator *Amblyseius hutu* (Prichard & Baker) Acari: Phytoseiidae) as a Potential Biological Control Agent for *Tetranychus urticae*

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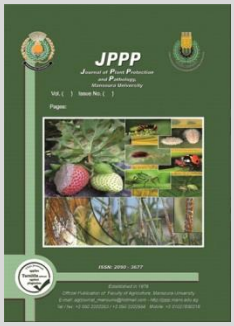

ABSTRACT

Tetranychus urticae Koch is an emerging pest of solanaceous crops worldwide. Under laboratory conditions (27±1.0°C & 70.0±5% RH), developmental times and reproductive parameters of *T. urticae* were evaluated on leaves of three plants (eggplant, tomato and pepper**).** Eggplant was most favorite plant for *T. urticae*, it recorded shorter life cycle (9.66 days for female), longest life span (19.56 days for female) and richened fecundity (75.72 eggs /female). While pepper was the lowest favorable plant for *T. urticae* because the pepper leaves when offered as a food for *T. urticae* longest life cycle (11.99 days for female), and reduced fecundity (19.66 eggs /female). Also Predatory mite *Amblyseius hutu* was reared on adult stages of *T. urticae* at 27±1.0 °C, 70.0±5 % RH and 16:8 L: D to evaluate the developmental period, fecundity rate and predatory potential after feeding different prey densities of *T. urticae*. There were three treatment with ratio two, four and six predator for Each experiment with 60 eggs and ten newly emerged *T. urticae* females. *A. hutu* female when fed on adult stages of *T. urticae* completed the developmental period in 4.90 days. Total of *T. urticae* females and eggs consumed throughout the whole experiment by 2, 4 and 6 individuals predator of *A. hutu* were 0.34, 0.75 and 3.00 prey females and, 6.00, 9.00 and 12.27 prey eggs respectively. The treatment three (6 individuals predator) had the shortest extinction time for spider mite (6 days).

Keywords: phytophagous mites, *Tetranychus urticae*, *Amblyseius hutu*, predacious mites, biology

INTRODUCTION

Tetranychus urticae Koch, is an important pest species in annually cultivated plants grown in greenhouse. This mite attacks a wide range of vegetables, field crops, fruit trees, ornamental plants and weeds (Zaher, 1984). The two spotted spider mite *T. urticae* Koch, is considered a significant pest to vegetables in important production areas in Egypt. Feeding of *T. urticae* causes yellow spots on the leaves and in heavy infestations, foliage has a yellowing or bronzing appearance and may suffer from premature leaf drop (Evans 1992). The rapid developmental rate, high reproductive potential, and arrhenotokous parthenogenesis in *T. urticae* allows them to achieve damaging population levels very quickly when growth conditions are good, resulting in an equally rapid decline of host plant quality (Kanika 2014). The degree of leaf damage by *T. urticae* is a function of its stylet length and leaf thickness (Park & Lee 2002). The life cycle of *T. urticae* has been studied by several authors (Ali *et al.* 2017, Vinothkumar & Ramaraju 2018, Jessica *et al*. 2020 and Carlos *et al*. 2018) which passes through five developmental stages: egg, larva, protonymph, deutonymph, and adult. Traditionally *T. urticae* has been controlled with acaricides, resulting in problems of pesticides resistance in the consumed products (Campos and Omoto 2002). Biological control is economically viable and environmentally safe to control insect and mites pests (Bakker 1993). The predatory mites belonging to family Phytoseiidae are potential bio-control agents for the control of phytophagous mites. So many researchers assayed some predators of family Phytoseiidae for control the pest mites (Messelink & Holstein 2006, Maria *et al.* 2012, Pia *et al* 2015. Gemma *et al.* 2015, Al-Alawi 2019, Gemma 2015 and Yan-Yan *et al.* 2016). *Amblyseius hutu* (Acari: Phytoseiidae) is an important predator species was found associated with *T. urticae* in many vegetable crops and countries. Many species of Phytoseiidae were tested to enhances the biological control of mite ant insect pests. Five phytoseiid species were tested to evaluate their potential as predators of *Phthorimea operculella* and *Spodoptera littoralis* eggs as an alternative food substance in the laboratory (EL-Sawi and Momen 2005). Thus, *Amblyseius aerialis* can be a biological control agent of the *T. urticae*, reducing the population of the pest and maintaining its fecundity in all phases and densities offered (Anilde da Graça *et al* 2018). *Amblyseius deductus* after feeding different prey densities of two spotted spider mites (*Tetranychus urticae*) the deutonymph, pre-oviposition, ovoposition and post-oviposition showed significances differences means in all three treatments (Muhammad *et al.*2013). The predator *Amblyseius largoensis* is likely to accept and consume high numbers of *Raoiella indica* eggs regardless of their all feeding experience (Daniel *et al* 2012). The population of *Amblyseius largoensis* is well adapted to survive high RH

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conditions, its efficiency as a biological control agent might be limited in drier inland areas (Cristina *et al*. 2018). The objective of this work was to evaluate the potential for predation of *Amblyseius. hutu* (Prichard & Baker), fed on deferent stages of *T. urticae*, and assess the predator biology when fed on adult stage of *T. urticae* on constant temperatures (27±1°C) and 70±5% Rh at laboratory conditions. Also evaluate the effect of three plants (eggplant *Solanium melongena*, tomato *Lycopersicon esculentum*, and pepper *Capsicum annum*) on duration of the developmental stages, adult longevity, life span and fecundity of the spider mite *T. urticae* on temperatures (27±1°C) and 70±5% RH. at laboratory conditions.

MATERIALS AND METHODS

1. Biological Studies:

Biological experiments on the phytophagous mite *Tetranychus urticae:*

The duration of the developmental stages, adult longevity, life span and fecundity of the spider mite *T. urticae* were studied on leaves of three plants (Eggplant, Tomato, and pepper) at laboratory conditions leaf disc plants (2 cm diameter) were placed on cotton pad in phil dish (20 cm × 15 cm) with under surface upward. The cotton pad was kept wet by soaking with water twice daily so that the discs remained fresh. Ten *T. urticae* adult females collected from the laboratory stock cultures were transferred to each disc for laying eggs. For solitary rearing, newly deposited eggs of the same age were transferred singly, each to a leaf disc. Every dish contained 25 discs. Dishes with discs were kept in an incubator with constant temperatures 27±1°C and 70±5% relative humidity. Discs of all treatments were examined twice daily and all biological aspects were recorded until death of mite individuals. Life tables of *T. urticae* were constructed from the life span and fecundity data. The actual death occurred in the egg and immature stages were taken into account when the female survival rate was determined. The distributions of all biological data were tested by Shapiro-Wilk method (SPSS, 2015).

Biological experiments of predaceous mite *Amblyseius hutu.*

The predatory mite, *A. hutu* was collected from Eggplant crop and a stock culture of *A. hutu* was prepared. Leaves of bean *(Phaseolus vulgaris)* were used as a substrate for rearing the predator, leaf discs of 3cm. in diameter were put in Petri-dishes on piece of cotton, Drops of water were daily added to maintain suitable moisture for the predator. Whenever, a leaf substrate began to deteriorate, it was replaced with another fresh one. To rear the phytosiid predator, couples of females and males of predator mite were transferred to plant discs of bean and supplied with sufficient number of immature stages of *T. urticae.* Newly laid eggs of the predator were transferred singly to discs of bean. Dishes which carrying discs were kept in an incubator with constant temperatures 27±1°C and 70 % relative humidity. All treatments were examined twice daily and all biological aspects were recorded until death of mite. Life tables of *A. hutu* were constructed from the life history and fecundity data. The actual death occurred in the egg and immature stages were taken into account when the female survival rate at temperature. Life tables were constructed using the survival data using the basic computer program.

2 The Predation efficiency of *Amblyseius hutu* on *Tetranychus urticae.*

Phytophagous mite:

The two spotted spider mite, *T. urticae* was cultured on the bean plants in the greenhouse. Three plants were put in a large tray (50 x 35 x 20 cm) and infested with 100 gravid spider mites. Each plant pot was placed on an empty inverted pot to avoid water logging the plant roots, as the tray contained water to prevent the mites from escaping. Two infested plants were replaced with fresh uninfected plants once a week to ensure the continuation of the culture.

Predatory mite species:

Predatory mite *Amblyseius hutu* was reared on two-spotted spider mite, *T. urticae*. *Amblyseius hutu* was reared using methods modified from **(**McMurtry and Scriven, 1965**),** large plastic boxes 26 x 15 x 10 cm. was used. Cotton pad were placed in the middle of each box, leaving a space provided with water as a barrier to prevent predatory mites from escaping. Excised bean leaves highly infested with *T. urticae* were provided every day as a food source for mites. Water was added to the plastic pan whenever required to prevent the mites from escaping. The culture units for all species were kept at room temperature (27 ± 1 °C).

Experimental design:

An experimental large petri–dish (10 cm) consisted of 1 bean leaf disc (4cm. diameter) kept upside down on a filter paper (10 x 10 cm), which was placed on the same-sized saturated cotton wool (1cm. thick). Water was added, as required, to prevent the mites from escaping and to keep the leaf disc turgid. A total of 40 experimental petri-dishes (10cm. diameter) were divided into three treatments and anther one as a control, with ten replicates in each treatment. The boxes were maintained in an incubator at 27 ± 1°C, 16 L: 8 D photoperiod and 70 ± 5 % R.H.

Experimental procedure:

The experiment started with 60 eggs and ten healthy gravid *T. urticae* females placed on each leaf disc to deposit eggs. Leaf discs infested with 10 healthy, gravid spider mite females were left for 24 hours. The number of eggs was adjusted to 60 by removing or adding eggs with a fine camel hair brush. Into each replicate a total of six predator females were introduced; six of a single species and three each for two species as shown in Table (1). The control had 10 spider mite females and 60 eggs of spider mite without any predatory mite species.

Table 1. Predatory mite *Amblyseius hutu* composition of each treatment.

Treatments	Predators	Prey	
		Adults females	Eggs
Tretm.1	2	10	60
Tretm.2	4	10	60
Tretm.3	6	10	60

3 Data analysis

The number of eggs and adult spider mites consumed were calculated according to the following equations:

$A_c = A_o - A_r - A_m$ **Number of adults consumed.**

$E_{Ar} = A_r \times R$ **Number of eggs laid by adults remaining**

$E_{Ac} = \frac{A_c}{2} \times R$ **the number of eggs laid by consumed prey is approximated by eggs laid.**

The resultant was divided by 2 because it is not known whether they were consumed before or after they laid eggs. There was no effect from day (light) and night (dark) on predation rate for the predators with fixing the temperature.

Total eggs offered (T_{Eo}) = $E_o + E_{Ar} + E_{Ac}$.

The number of eggs consumed by the predators can be estimated by eggs consumed.

Eggs consumed (E_c) = T_{Eo} - E_r.

A_c = Number of adults consumed.
A_m = Mortality of adults.
A_o = Number of adult offered.
A_r = Number of adult remained.
E_{Ac} = Number of eggs expected laid by adults consumed.
E_{Ar} = Number of eggs laid by adult remained.
E_c = Number of eggs consumed.
E_o = Number of eggs offered.
E_r = Number of eggs remained.
R = Expected daily number of eggs produced per adult female (based on control group).
T_{Eo} = Total number of expected eggs offered. (Abdallah, 2002)

RESULTS AND DISCUSSION

1- Influence of host plants on the biology of *Tetranychus urticae* at 27±1°C and 70±5 % RH.

Both male and female of *T. urticae,* development proceeds through: egg, larva, protonymph, dutonymph, and adult. The stages from larva to dutonymph are further divided into feeding period (active) and quiescent period (resting) stages.

The results in Table (2) illustrated that, when *T. urticae* reared on different solanaceous plants, eggplant, tomato and pepper all moving stages were affected by host plants. eggplant and tomato were more preferred to *T. urticae* they accelerated immature stages, life cycle and reached fecundity. While, the pepper was the lowest favorable food. duration of larva, protonymph and dutonymph are further divided into two periods of each, the 1st feeding or active period and the 2nd quiescent or resting period. The total immature stages averaged 5.76 and 6.06 days for female and 5.16 and 5.20 days for male when the mite fed on eggplant and tomato respectively; while when *T. urticae* fed on pepper the total immature stages averaged 8.19 for female and 7.20 days for male. The shortest life cycle of female and male were observed when *T. urticae* fed on leaves of eggplant and tomato, it averaged 9.66 and 10.06 days for female and 8.52 and 9.06 days for male on eggplant and tomato respectively, while the longest life cycle period was observed on leaves of pepper, it recorded 11.99 days for female and 10.80 days for male. Also the duration of longevity and life span were affected by food type. when the mite fed on eggplant the longevity and life span were the longest, the female and male longevity were 9.90 and 6.50 days respectively. while life span was 19.56 and 15.02 days for female and male respectively, whereas when leaves of tomato and pepper used as foods, the longevity and life span of female and male showed similar trend with slightly differences. The longevity of *T. urticae* when fed on tomato and pepper was 7.73 and 5.12 days for female and 5.10 & 4.40 days for male fed on above mentioned food respectively. While when *T. urticae* fed on the same foods the life span was 17.79 and 17.11 for female and 14.16 & 15.20 days for male respectively.

The Total number of deposited eggs per female of *T. urticae* as shows in Table (3) averaged 75.72 and 52.36 eggs when reared on eggplant and tomato leaves respectively, while on leaves of pepper was 19.66 eggs. Also the Oviposition period was affected by food type, when *T. urticae* reared on eggplant the oviposition period was the longest period with mean 7.43 days, while leaves of tomato and pepper when offered to *T. urticae* females as a food the oviposition period shortest with mean 5.63 and 3.00 days on tomato and pepper respectively. The generation time was 11.06 and 11.32 days when spider mite reared on eggplant and tomato leaves respectively, but when reared on leaves of pepper it was 13.18 days.

Table 2. Duration of developmental stages of *Tetranychus urticae* reared on leaves of three solanaceous plant, eggplant, tomato, pepper at 27± l °C and 70 ± 5 % RH.

stages	sex	Duration in day ± SD		
		Solanaceous plant		
		Eggplant	Tomato	Pepper
Incubation period	♀	3.90±1.02 a	4.00±1.06 a	3.80±0.68 a
	♂	3.36±0.66 a	3.86±0.91 a	3.60±0.22 a
Larva	♀	2.40±0.96 a	2.70±0.52 a	3.95±0.78 c
	♂	1.96±0.54 a	2.30±0.67 a	3.60±0.22 c
Protonymph	♀	1.73±0.45 a	1.73±0.41 a	2.73±0.63 c
	♂	1.60±0.65 a	1.20±0.27 a	1.90±0.54 a
Dutonymph	♀	1.63±0.22 a	1.63±0.39 a	1.51±0.39 a
	♂	1.60±0.41 a	1.70±0.44 a	1.70±0.44 a
Total immatures	♀	5.76±0.52 a	6.06±0.59 a	8.19±0.94 c
	♂	5.16±0.65 a	5.20±1.25 a	7.20±0.67 c
Life cycle	♀	9.66±0.52 a	10.06±0.82 a	11.99±0.63 c
	♂	8.52±1.00 a	9.06±0.57 b	10.80±0.75 c
Longevity	♀	9.90±1.03 a	7.73±1.59 b	5.12±0.82 c
	♂	6.50±1.69 a	5.10±1.19 b	4.40±0.54 b
Life span	♀	19.56±1.11 a	17.79±1.38 b	17.11±1.11 b
	♂	15.02±1.03 a	14.16±1.03 b	15.20±0.57 a

Table 3. Generation and fecundity of *Tetranychus urticae* female on three solanaceous plants eggplant, tomato and pepper at 27±l °C and 70 ± 5 % RH.

Periods	Duration in day ± SD		
	Solanaceous plant		
	Eggplant	Tomato	Pepper
Pre-oviposition	1.4±0.33a	1.26±0.37b	1.20±0.33b
Oviposition	7.43±1.13a	5.63±1.31b	3.00±0.65c
Post oviposition	1.06±0.31a	0.83±0.40a	0.92±0.35a
Generation	11.06±0.59a	11.32±0.72b	13.18±0.84c
Fecundity	75.72±12.04 a	52.36±15.52b	19.66±4.30c
daily rate	10.19± 2.26	9.30±3.65	6.55±1.24

Statistical analysis of the obtained results revealed that, occurrence of significant differences between developmental duration periods of *T. urticae* when reared on leaves of eggplant, tomato and pepper, greatly effected on fecundity and life table. These results in agreement with those stated by Vinoth and Ramaraju (2018) they evaluated the biology and development duration of *T. urticae* to explore the developmental duration on four popular tapioca varieties (Thailand, Co (DB) 4, Yethapur 1 and Sri Reka). They observed that, the total developmental duration of *T. urticae* was 9.6 ± 0.55 days in Thailand variety as highly resistant followed by 5.4 ± 1.52 days in Sri Reka shows highly susceptible one, Co (DB) 4 recorded (7.4 ± 0.89 days) as moderately resistant and Yethapur 1 shows (6.6 ± 2.07 days) moderately susceptible. Also (Metwally *et al.* 2014) studied the developmental times and reproduction rate of *T. urticae* on leaves of four maize single crosses (i.e. YSC3080, Bacheir13, SC122 and SC10) at laboratory conditions on 28±2°C, 65±5 % RH and 16:8 L: D. they observed the Immature developmental time of *T. urticae* was longest on SC10 (6.7days) and yellow SC122 (5.5 days) than Bacheir13 and YSC3080 (5.1days). Longevity of *T. urticae* was 12.8, 10.4, 9.9, and 9.8 days on YSC3080, Bacheir13, SC122 and SC10, respectively. The results also agree with (Carlos *et al* 2018); Razmjou *et al.* (2009) and Abdel-Moneim, (2013). they stated that, the

differences of plant species or varieties effect on the increase potentials for tetranychid mites, and these differences might be associated with the nutriment produced by plant. Additionally, (Nabi 2017) mentioned that, significantly lower life table parameter values (rm, Ro and T) for *T. urticae* were observed on cv. BT-Ince Sivri, followed by cvs BT-Burdem and BT-Burkalem when reared on six pepper cvs BT-Ince Sivri, BT-Burdem, BT-Burkalem, AHCRI-Çarliston, AHCRI-Yağlık and AHCRI-Kandil Dolma. The results also agree with those obtained by (Thirupam and Bontha 2017) they studied biology of *T. urticae* mulberry leaf under laboratory conditions (27±1°C and 75±5% RH). They found that, total developmental period was 12.23 and 10.23 days for female and male respectively. These variations determined on three different Solanaceous plant might be due to leaf chemical contents, food quality, or to the leaf texture. These leaves characteristics significantly affected on the oviposition and development stages of *T. urticae* and playing an important role in the direct resistance to *T. urticae.*

2- Biology of the predatory mite *Amblyseius hutu* at 27±1Cº and 70±5% RH. fed on adult female of *Tetranychus urticae.*

Results in Table (4) showed that, the incubation period of *A. hutu* lasted 1.20±0.42 and 1.50±0.35 days for female and male respectively. The average duration of the female larval stage of the predator *A. hutu* lasted for 1.05 ± 0.28 days, while the male larval stage averaged 0.90 ± 0.22 day. The duration of female protonymphal stage of the predator when fed on adult stages of *T. urticae* lasted 0.95±0.36 day while for male lasted 1.00±0.35 day. The deutonymphal stage of the predator *A. hutu* female lasted 1.20±0.34 days while for male lasted 1.00±00 day. The immature stages of the predator female lasted 3.20±0.63 days while immature stages of male lasted 2.90±0.41 days. The results regarding developmental period from egg to adult of *A. hutu* required 4.90±0.39 days for female and 4.40 ± 0.22 days for male in the laboratory at an average temperature of 27±2°C, 70±5% RH. The female longevity of the predator durated 9.80±0.97 days while longevity period of male lasted 6.50 ± 1.00 days. The female life span durated 14.20±1.03 days while male lasted 10.90±0.89 days. The female pre-oviposition period was 2.60 ± 0.65 days, and oviposition period of the predator durated 6.35±1.43 day. while post-oviposition period of the predator female durated 0.85±0.62 day. The female generation time recorded 7.50±0.57 days. The female fecundity reached 9.80±2.57 eggs per female.

Table 4. Mean Developmental periods and Fecundity of the predatory mite *Amblyseius hutu* when fed on *Tetranychus urticae* Koch at 27°C ±1 and 70±5 % RH.

Developmental periods	(Mean ± S.D.)	
	Female	male
Incubation period	1.20±0.42	1.50±0.35
Larva	1.05±0.28	0.90±0.22
Protonymph	0.95±0.36	1.00±0.35
Deutonymph	1.20±0.34	1.00±0.00
Total immature	3.20±0. 63	2.90±0.41
Life cycle	4.90±0.39	4.40±0.22
Longevity	9.80±0.98	6.50±1.00
Life span	14.20±1.03	10.90±0.89
Pre-oviposition	2.60±0.65	__
Oviposition	6.50±1.43	__
Post-oviposition	0.85±0.62	__
Generation	7.50±0.57	__
Fecundity	9.80±2.57	__

These results are in agreement with data obtained by (Muhammad *el al.* 2013), they reared the predator *Amblyseius deductus* feeding on different prey densities of two spotted spider mites *T. urticae* with the ratio of predator and prey i.e. T1 (1:5), T2 (1:7) and T3 (1:9). They observed the maximum fecundity was recorded in T3 (1:9) third treatment i.e. 24.33±1.33 eggs as compared to other two treatments means after feeding on *T. urticae*. (Anilde da Graça *et al.* 2018) Explained that, when offered the nymph and adult of T. urticae for *Amblyseius aerialis* the average number of eggs per day was higher. (Ernesto ***et al*** 2009) explained that**,** *T. urticae* was the best food for both the postembryonic development and the oviposition rate (100% of attained adulthoods and 2.65 eggs/female/day were laid).

3- Efficacy of *Amblyseius hutu* on the two-spotted spider mite, *Tetranychus urticae*.

The study was carried out to determine the efficacy of predatory *Amblyseius hutu* in reducing the population densities of *T. urticae* on detached bean leaves under controlled laboratory conditions.

1- Predation on adult spider mite females:

Data in Table (5) showed that, by using three treatments of releasing 2, 4 and 6 individuals of the predator *A. hutu*. The observed values of adult prey *T. urticae* consumption for *A. hutu* at first day through three treatments were 0.30, 0.45 and 0.27 pray femal, per predator for treatments 2, 4 and 6 predator respectively. While, in second day the adult prey consumption in the three treatments were 0.70, 0.25 and 0.43 pray per predator, for treatments 2, 4 and 6 predator respectively. Daily average number of adult prey consumption in the three treatments 2, 4 and 6 predator were 3.00, 0.75 and 0.34 individuals per predator, respectively.

Table 5. Mean of consumption of *T. urticae* females by 2, 4 and 6 individuals predators of *Amblyseius hutu* under laboratory condition (per capita).

No. of tret.	Predatory individuals	Average number of consumption rate (adult female) per predator			
		During first day	During second day	Throughout the whole experiment	Extinction time
		Mean ± SE	Mean ± SD	Mean ± SD	Days
1	Two	0.30 ± 0.20	0.70 ± 0.20	3.00 ± 1.34	10
2	Four	0.45 ± 0.23	0.25 ± 0.11	0.75 ± 0.51	8
3	Six	0.27 ± 0.04	0.43 ± 0.07	0.34 ± 0.05	6

Statistical analysis of the obtained results revealed that, wasn't significant difference among the three treatments 2, 4 and 6 individuals of the predator mite in the first, second day and throughout the whole experiment of the adult *T. urticae* as prey consumption by *A. hutu* among three treatments. While, there was significantly difference between control and the adult prey consumption by 2, 4 and 6 individuals of the predator mite among the three treatments.

2- Predation on spider mite eggs:

Data in Table (6) showed that, the observed value of eggs consumption for *A. hutu* by using three treatments 2, 4 and 6 individuals of the predator mite at first day in the three treatments were 8.80, 2.65 and 7.49 eggs per predator, respectively. While, in second day the daily eggs consumption by the three treatments 2, 4 and 6 predator were, 12.3, 10.17 and 6.68 eggs per predator respectively. Daily average numbers of eggs consumption by the predator at three treatments were 12.27, 9.00 and 6.00 eggs per predator, respectively.

Statistical analysis of the obtained results revealed the three treatments there were significantly differences of the egg

consumption among the treatments in the first, second day and throughout the whole experiment among three treatments.

Table 6. Mean of consumption of *T. urticae* eggs by 2, 4 and 6 individuals predators of *Amblyseius hutu* under laboratory condition (per capita).

No. of tret.	Predatory individuals	Daily Average number of egg consumption per predator: During first day Mean ± SE	During second day Mean ± SD	Throughout the whole experiment Mean ± SD	Extinction time Days
1	Two	8.80 ± 1.76	12.3 ± 1.16	12.27 ± 3.33	10
2	Four	2.65 ± 1.24	10.17 ± 2.62	9.00 ± 2.28	8
3	Six	7.49 ± 1.81	6.68 ± 2.11	6.00 ± 1.09	6

3- Prey extinction time:

Adult prey and eggs extinction

Total prey extinction: The time taken by the different treatment of *A. hutu* to drive the total spider mite populations to zero was significantly different among treatments.

Treatment one (2 individuals predator) had the longest time for spider mite extinction (10 days), the increase in *T. urticae* population continued until the fifth day of treatment with average (124) then decreased to zero at the tenth day Fig (1).

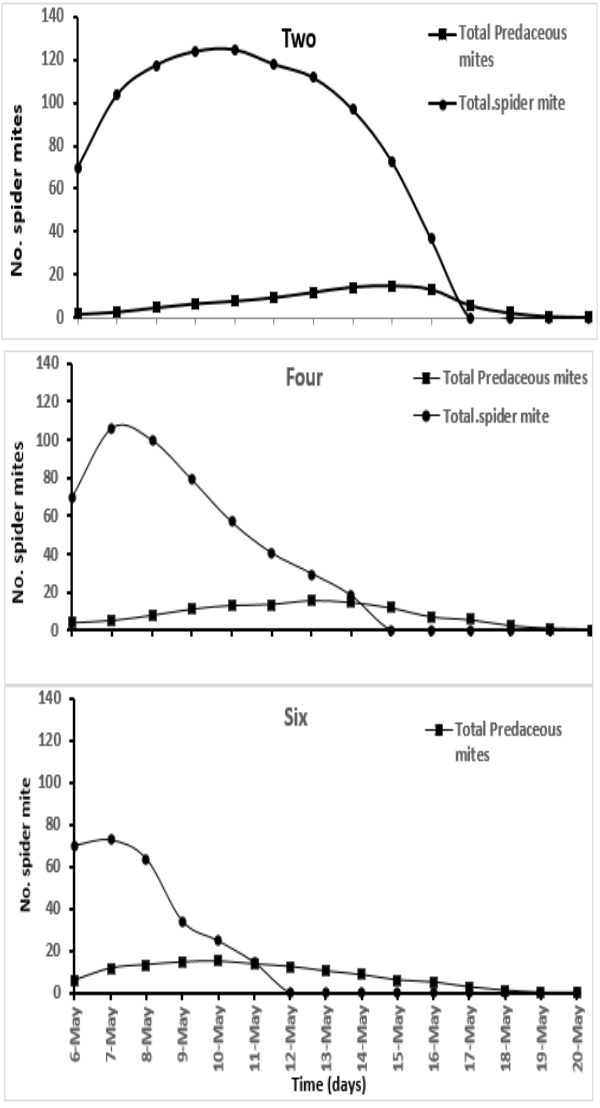

Fig. 1. Population size of spider mites during three treatment (2,4 and 6 individuals) of predatory mite *Amblyseius hutu*.

While treatment two (4 individuals predator) the population continued in increase until the second day of treatment with average (106.2) then decreased in the third day even reached to zero at the eighth day. In the treatment three (6 individuals predator) had the shortest extinction time for spider mite (6 days) it started in decreased at the second day of treatment with average (72) then decreased in even reached to zero at the sixth day. Fig (1).

4- Overall daily changes in spider mite populations and their extinction

As showing in (Fig. 2), the number of spider mite eggs increased reaching peak density (259.6 eggs) until eighth days (13May) and then the population decreased due to hatching of the initial eggs to movable immature stages (larvae, after that they molting to nymphal stages) till ninth day and it is decreased to the end of the experiment. The number of the larvae stage increased from third day to reaching peak density (79.4 individuals) at eighth day (13May), and then decreased at ninth day then increased until twelfths day (17May) and it is decreased to the end of the experiment.

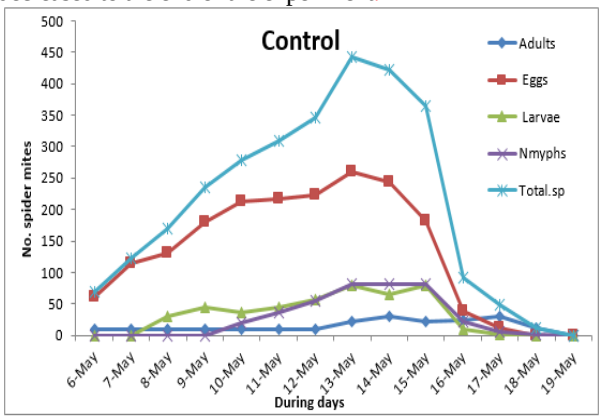

Fig. 2. Population size of different spider mite stages (Control treatment) and the total through the experiment.

The number of the nymphal stages increased from fifth day (10May) to reaching a peak density (81.8 individuals) in eighth day (13May), but it decreased again to until tenth day(15May) and then decreased until twelfths day (17May), but it decreased again to the end of experiment. The number of the adult stage increased from eighth day (13May) to reaching peak density (30.6 individuals) in twelfth day (17May), and then decreased gradually to the end of the experiment because food limitation (the leaf resources were exhausted). Whole, the total spider mite population started to increase rapidly until the eighth day, by average (442.2 individuals) then it decreased gradually to the end of the experiment.

5- All spider mite prey extinction:

Total prey extinction:

The time taken by the different treatment by predatory mite *A. hutu* to drive the total spider mite populations to zero was significantly different among treatments. (Fig.3). Six individuals of the predator mite and 4 individuals of the predator mite had the shortest time for spider mite extinction (6 & 8 days), respectively. While in the first treatment (2 individuals) of the predatory mite the longest decreased to zero 10 days**.** Those in agreement with **(**El-Saiedy *et al.* 2008) they demonstrated that, the population density of *T. urticae* on two eggplant cultivars was greatly reduced after the introduction of the predators *Phytoseiulus persimilis* Athias-Henroit,

Neoseiulus cucumeris Oudemans and *Neoseiulus californicus* McGregor. Also (Susan 2018) showing that a ratio of one predator (Neoseiulus californicus) to five spider mites is effective at reducing spider mite populations. (Giselle *et al.* 2014) concluded that N. californicus is efficient in controlling the *T. urticae* under greenhouse conditions. Whereas (Omar and Amira 2015) explained that. feeding capacities of the predator *Amblyseius cydnodactylon* (Shehata & Zaher) protonymph and deutonymphal stages were increased with increasing temperature from 20°c to 25°c, and then decreased at 30°c and finally, increased again at 35°c. The present results indicated that *A. hutu* used to drove the prey population to extinction on the shortest time in the case of the present small-scale experiment, but when used in large numbers of predator, it able to drive the total spider mite populations to zero. this drives us to use the same technique in a larger scale in a system to check if these results will be the same case over a larger scale or not.

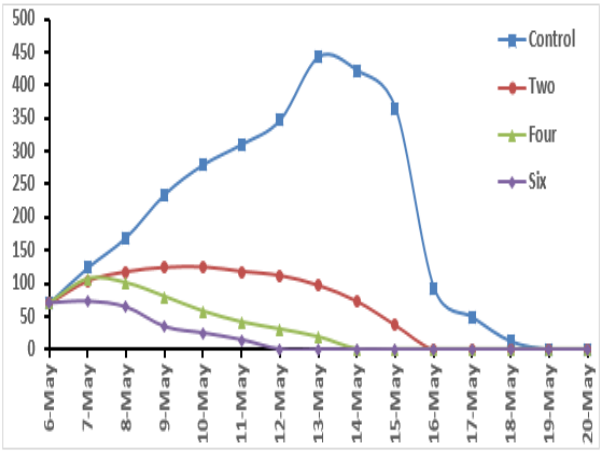

Fig. 3. Effect of predatory mite *Amblyseius hutu* on extinction time of Total spider mite populations.

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مقارنة احيائية لحلم العنكبوت الأحمر *Tetranychus urticae* Koch (Acari: Tetranychidae) على ثلاث نباتات من الفصيلة الباذنجانية (Solanaceae) وامكانية استخدام المفترس الأكاروسى *Amblyseius hutu* (Acari: Phytoseiidae) كأحد عناصر المكافحة الحيوية لحلم العنكبوت الأحمر

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يعد حلم العنكبوت الأحمر *Tetranychus urticae* من أهم الآفات الأكاروسية التي تصيب الفصيلة الباذنجانية على مستوى العالم. ، لذا تم اجراء هذه الدراسة طبقا للاتي:- اجريت تجربه احيائية معملية على حلم العنكبوت الاحمر على درجة حرارة 27±1°م ورطوبة نسبية 70±5 % وعلى اوراق ثلاث انواع من النبات التابعة للفصيلة الباذنجانية (الباذنجان *Solanium melongena* والطماطم *Lycopersicon esculentum* والفلفل *Capsicum annum*) لمعرفة مدى تأثير العائل النباتي على مقاييس جداول الحياة ومعدل الخصوبة لأكاروس العنكبوت الأحمر. وقد تبين من النتائج المتحصل عليها ان الباذنجان هو النبات الأكثر تفضيلاً للعنكبوت الأحمر تلاه نبات الطماطم ثم الفلفل في المرتبة الأخيرة, حيث سجل الحلم اقصر دورة حياة (9,66 يوم الأنثى) على الباذنجان واطال فترة العمر (life span) حيث بلغت 19,56 يوم للأنثى كما زادت خصوبة الانثى فكانت 75,72 بيضة/انثى عند تغذية الحلم على الباذنجان. بينما كان نبات الفلفل هو النبات الأقل تفضيلاً لدى العنكبوت الأحمر حيث انه اعطى اطول دورة حياة (11,99 يوم للأنثى) وخفض خصوبة الانثى (19,66بيضة/انثى)، لذلك كانت اوراق الفلفل هي الأقل افضلية من بين الأغذية الثلاث. كما اجريت تجربه احيائية معملية على الحلم المفترس *Amblyseius hutu* على درجة حرارة 27±1°م ورطوبة نسبية 70±5 % ، 8 ساعات اظلام : 16 ساعة اضاءة متغذياً على الطور الكامل لحلم العنكبوت الأحمر، وتبين من النتائج ان المفترس استطاع التغذية على الطور الكامل لحلم العنكبوت الأحمر وأكمل دورة الحياة في 4,90 يوم للأنثى و فترة الطور الكامل (longevity) سجلت 9,80 يوم للأنثى وبلغت الخصوبة 9,80بيضة / انثى . ايضاً اجريت تجربة اطلاق للمفترس الأكاروسى *Amblyseius hutu* بمعدل ثلاث مستويات اطلاق 2 ، 4 ، 6 افراد من الحلم المفترس مقابل 10 اناث بالغة و60 بيضة للحلم الأكاروسى *T. urticae* نباتي التغذية لمعرفة عدد البيض والاناث الكاملة التي يمكن ان يلتهمها المفترس خلال فترة التجربة التي استمرت لمدة اسبوعين كما تم تحديد الفترة اللازمة للمفترس التى يفترس فيها كل الافراد المقدمة له. من خلال النتائج المتحصل عليها وجد ان متوسط الافتراس الكلى للفرد الواحد من الحلم المفترس خلال التجربة هو 3,00 فرد و 12,27 بيضة لمستوى الاطلاق الأول و 0,75 فرد من الاناث و 9,00 بيضات لمستوى الاطلاق الثاني أما مستوى الاطلاق الثالث فكان متوسط الافتراس 0,34 فرد من الاناث البالغة و 6,00 بيضة، اما الوقت اللازم لكل مستوى اطلاق حتى يقضى على الأفراد المقدمة له فكانت 10، 8، 6 ايام للمستويات 2، 4، 6 افراد من المفترس على الترتيب. في النهاية يمكن ان نقول ان المفترس *Amblyseius hutu* الذى يوجد في البيئة المصرية مصاحباً للعنكبوت الأحمر الذى يصيب الخضروات يصلح ان يدرج في برنامج المكافحة البيولوجية لأن ستة افراد من المفترس استطاعت ان تلتهم 60 بيضة وعشرة افراد بالغة من العنكبوت الأحمر في غضون ستة ايام.