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Article

Life table parameters of *Tetranychus urticae* (Trombidiformes: Tetranychidae) on four strawberry cultivars

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ABSTRACT
The two-spotted spider mite, *Tetranychus urticae* Koch is one of the most important pests of strawberry plants worldwide. The present study compared the biology and life table parameters of *T. urticae* on four strawberry cultivars, including Wanter star, Markez, Fortona and 029 under laboratory conditions. Female developmental times showed a significant difference when recorded on tested cultivars, while such a difference was not observed for the male ones. The developmental time was significantly longer on Wanter star and Fortona in comparison with the others ($P = 0.00$). Females of *T. urticae* exhibited the shortest oviposition period and adult longevity on Fortona and Wanter star, while having the longest periods on 029 in this report ($P = 0.00$). The lowest fecundity and daily eggs laid by females were recorded on Wanter star. The highest rate of fertility was recorded on 029 as compared to other cultivars; therefore, Wanter star is introduced as a resistant cultivar against *T. urticae* infestation.

KEY WORDS: Acari; life history; Rosaceae; Tetranychoidea; Two-spotted spider mite.

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INTRODUCTION

The two-spotted spider mite (TSSM), *Tetranychus urticae* Koch (Acari: Tetranychidae), is one of the most important polyphagous pest species that can attack many agricultural greenhouse plants and field crops (Khanamani *et al*. 2014; Tehri 2014; Azadi-Qoort *et al*. 2019). Strawberry (*Fragaria x ananassa* Duchesne) (Rosaceae) is a small fruit crop and one of the most important fruits in the berry family due to its characteristic flavor, rich vitamins and other fruity ingredients (Hancock 1990). In Egypt, strawberry is considered of great economic importance, as it has become an export product to the Arab and European markets. Strawberry plants are susceptible to *T. urticae* in the pre-flowering and flowering periods (Sato *et al*. 2004). Reduction of plant growth and yield would be a result of severe infestation of strawberry leaves by *T. urticae* which finally affects the quality and quantity of produced strawberries (Klamkowski *et al*. 2006; Rezaie *et al*. 2013).

The short development time, lifespan and high fecundity allow the TSSM to increase its population in a short period and achieve plant damage very quickly when the environment is suitable for the pest, resulting in a decline in the quality of host plants products (Fathipour *et al*. 2006; Sedaratian *et al*. 2011).

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The pest controlling schemes exclusively depend upon the use of acaricides (Van Leeuwen *et al*. 2005). The complexity to manage this pest is its potential to build up multiple resistances to many acaricides (Lee *et al*. 2003; Kim *et al*. 2006). Besides, the broad use of the synthetic pesticide causes an unpleasant effect on a human being, predators, parasites and the environment (Kumral *et al*. 2010). Studies have continuously been done to identify alternative control methods to the chemical ones (Gardiner *et al*. 2005; Razmjou *et al*. 2006). The host plant resistance is a safe process for controlling pests as it is inexpensive and naturally safe (Li *et al*. 2004; Zehnder *et al*. 2007; Sedaratian *et al*. 2009). Therefore, it is important to choose those cultivars that are less favored by the pest and at least would lead to delayed outbreaks.

Some factors including chemical content (Afifi *et al*. 2010), leaf surface structure of host plants (Keskin and Kumral 2015), cultivar kind (Razmjou *et al*. 2009), climatic conditions (Bayu *et al*. 2017) and exposure to pesticides (Marcic 2003) affect development rate, fecundity and mortality of *T. urticae*. Several authors have indicated significant differences in susceptibility/resistance levels of *T. urticae* on strawberry plants (Petrova *et al*. 2000; Labanouska 2007; Afifi *et al*. 2010; Rezaie *et al*. 2013).

Fertility life table parameters of pest mites are important tools in evaluating susceptibility of the host plants growing under specific conditions (Bonato *et al*. 2000; Adango *et al.* 2006); the intrinsic rate of increase (r) is usually considered as a measure of the plant resistance level against pests (Leszczynski 1987). Therefore, plants that support pest populations and exhibit higher values of r are comparatively less resistant than those supporting the populations with lower values of r.

The aim of the present study was to obtain a clear image of the susceptibility of four commercial cultivars of strawberry grown in Egypt as host plants to the TSSM by considering life table parameters and biological characters of the pest. Knowing the least favorable strawberry cultivars to TSSM can help the growers to select the resistant ones in the field.

MATERIALS AND METHODS

Strawberry cultivars

Seedling of four strawberry cultivars (Wanter star, Markez, Fortona and 029) were obtained from Horticulture Research Institute, Cairo, Egypt and established in containers filled with aerated soil, and placed in greenhouse. Clean leaves at the same age were collected and used for leaf disc preparation in the experiments. No fertilizers and pesticides were used and the cultivated plants were irrigated at a similar time (3-day interval) with fresh water.

Culture of Tetranychus urticae

The stock culture of TSSM was originally collected from bean plants (*Phaseolus vulgaris* L.) grown in National Research Centre farm in Cairo, Egypt, and were transferred onto strawberry cultivars.

The TSSM used in each experiment was obtained from a culture maintained on whole plants of each cultivar (separately for each one) for at least 4 generations before starting the experiments. A thin paint brush was used to transfer the mites from old leaf discs to the new ones.

Leaf discs

For each cultivar, leaf discs cut from a leaflet collected from the middle part of plant were used. In each replicate a Petri dish of 6 cm in diameter was used. A leaf disc with 3.5 cm of diameter was placed on water-saturated cotton pad in Petri dishes. Water-saturated, absorbent cotton strip, 1 cm wide, was placed around the edge of the leaf discs to prevent mites from escaping.

Experiments

All experiments were performed at 27 ± 1°C, 60 ± 5% (RH) and a 16 L: 8D photoperiod in an incubator.

The development time, adult longevity and fecundity of *T. urticae* were assessed on four strawberry cultivars namely Wanter star, Markez, Fortona and 029. Newly emerged mated females of TSSM, obtained from the stock colony of each cultivar, were transferred into fresh leaf discs of each cultivar separately, so that oviposition could occur. After eight hours, only one egg was kept on each leaf disc, from which the development was monitored and the mites and additional eggs were discarded.

A capacity of 41, 37, 40 and 33 eggs of *T. urticae* were considered for 029, Fortona, Markez and Wanter star cultivars. The developmental stages for both females and males were as follows: egg, larva, protonymph, deutonymph and adult (male and female). The developmental stages were observed at 12 h intervals until they reached maturity. The presence of an exuvium was used as the criterion of successful molting to the next developmental stage. On the same cultivar, the newly emerged female was paired with a male. When it was necessary, young males from the mass rearing colonies maintained on the same cultivar were used for multiple mating with females.

The number of laid eggs was evaluated daily until the female death; eggs were removed to avoid double counting. To determine the sex ratio, three random samples (at least 50 eggs in each sample) were taken from the eggs laid at the beginning, middle and near the end of the female's oviposition period. The collected eggs were allowed to develop to adulthood and then their gender was determined. The leaf discs were replaced by the new ones. All observations were carried out until the death of adult mites.

Age-stage, two-sex life table

Developmental time of all individuals, including male and female, and female daily fecundity were analyzed according to the age-stage, two- sex life table theory (Chi and Liu 1985) and the method described by Chi (1988).

The age-stage specific survival rate (s_{xj}) (where x = age in days and j = stage); the age-stage specific fecundity (f_{xj}) (daily number of eggs produced per female on age x); the age-specific survival rate (l_x); the age-specific fecundity (m_x) (daily number of eggs produced per individual, i.e., this number is divided by all individuals (males and females) of age x) and the population parameters (the intrinsic rate of increase (r); the finite rate of increase (λ) that $\lambda = e^r$; the gross reproductive rate (GRR); the net reproductive rate (R_0) and the mean generation time (T) are calculated.

The age-specific survival rate includes both male and female, and is calculated according to Chi and Liu (1985) as:

$$l_x = \sum_{j=1}^{k} s_{xj}$$

and

$$m_x = \frac{\sum_{j=1}^{k} s_{xj} f_{xj}}{\sum_{j=1}^{k} s_{xj}}$$

where k is the number of stages.

The intrinsic rate of increase is estimated by using iterative bisection method from the following equation:

$$\sum_{x=0}^{\omega} e^{-r(x+1)} l_x m_x = 1$$

with age indexed from 0 to ω (maximum age).

The mean generation time is calculated as $T = \ln R_0 / r$. The R_0 is estimated by using:

$$R_0 = \sum_{x=0}^{\omega} \sum_{j=1}^{k} s_{xj} f_{xj}$$

The *GRR* is calculated as $GRR = \Sigma\, m_x$.

Female age-specific life table

In the female life table, the number of female progeny, survival rate of immature and female adult stages, daily fecundity and sex ratio were used for the estimation of different life table parameters. The estimated parameters were the age-specific survival rate (l_x), age-specific fecundity (m_x), r, λ, *GRR*, R_0 and T. The life table constructions in this section were adopted from Birch (1948).

In the construction of a female age-specific life table, it is necessary to calculate the age-specific survival rate (l_x) and the age-specific fecundity (m_x), based on female individuals, where l_x showing the probability that a newborn individual would survive to age x, and m_x is the mean number of female eggs laid per female adult at age x.

Statistical analyses

Developmental times, reproduction periods, fecundity and longevity along with population parameters (r, λ, *GRR,* R_0 and T) were calculated by using the TWOSEX-MSChart programme (Chi 2017). The means and standard errors of the population parameters were estimated by using the Bootstrap procedure with 100,000 re-sampling and the life table parameters of TSSM on different strawberry cultivars were compared by using a paired bootstrap test (Huang and Chi 2013).

RESULTS

Biological parameters

No significant difference was observed for the developmental stages of *T. urtice* males, while these periods were significantly influenced by cultivars for female individuals (Table 1). The females reared on Fortona and Wanter star cultivars took significantly more time to develop to adulthood than those reared on other ones (Table 1). Strawberry cultivars significantly influenced the duration of the oviposition period, while no significant differences were detected on the post-oviposition periods (Table 2). Mean oviposition period and female longevity were statistically shorter on Fortona and Wanter star (oviposition period: $P = 0.0001$), than on 029 and Markez.

Age-stage, two-sex life table

The age-stage specific survival rates (s_{xj}) of TSSM (Fig. 1) show the probability that a newborn will survive to age x and develop to stage j. These curves also show the survivorship and stage differentiation as well as the variable developmental rate. The probability that a newborn egg survived to the adult stage was 0.780, 0.676, 0.750 and 0.697 for females and 0.219, 0.324, 0.250 and 0.273 for males on 029, Fortona, Markez and Wanter star, respectively. According to these results, the lowest survival rate of a newborn egg to female adult stage is related to TSSM reared on Fortona.

Table 1. Mean developmental time (± SE) of *Tetranychus urticae* reared on four strawberry cultivars.

Developmental stages (day)	Strawberry cultivars			
	029 (32)	**Fortona** (25)	**Markez** (30)	**Wanter star** (23)
		Females		
Egg	4.13±0.18b	4.44±0.22ab	4.23±0.16ab	4.87±0.20a
Larva	2.41±0.09b	2.40±0.14b	2.17±0.07b	2.91±0.18a
Protonymph	1.94±0.04b	2.32±0.11a	1.77±0.08b	2.26±0.09a
Deutonymph	2.28±0.081b	2.92±0.22a	2.50±0.13ab	2.83±0.17ab
Egg–adult	10.75±0.32b	12.08±0.60ab	10.67±0.32b	12.87±0.51a
		Males		
	029 (9)	**Fortona** (12)	**Markez** (10)	**Wanter star** (10)
Egg	4.00±0.29a	4.42±0.26a	4.20±0.25a	4.80±0.29a
Larva	2.33±0.17a	2.50±0.15a	2.30±0.15a	2.60±0.16a
Protonymph	2.11±0.11a	2.08±0.08a	2.20±0.13a	2.40±0.16a
Deutonymph	2.67±0.17a	3.00±0.21a	2.40±0.16a	2.50±0.17a
Egg–adult	11.11±0.35a	12.00±0.55a	11.10±0.35a	12.30±0.52a

Numbers in parentheses represent the number of replicates.
The means in each row with the same letters are not significantly different (Paired bootstrap test, $P \leq 0.05$).

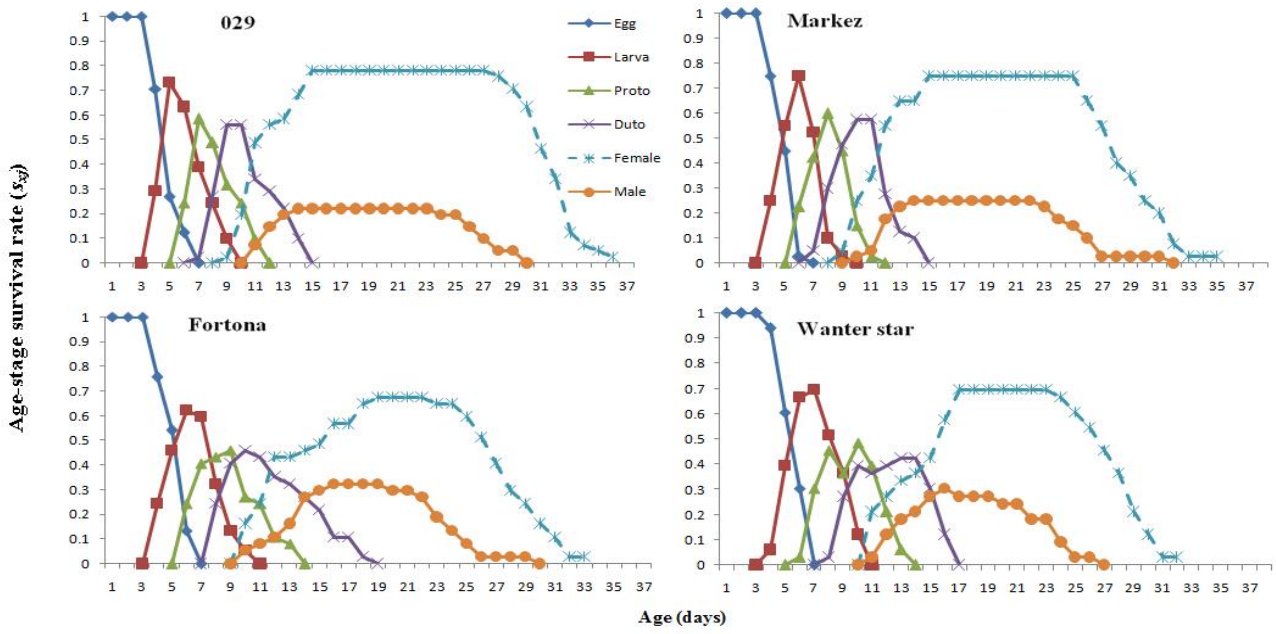

Figure 1. Age-stage survival rate (S_{xj}) of *Tetranychus urticae* on four strawberry cultivars.

Total and daily fecundity was significantly influenced by different strawberry cultivars (Table 3). Results revealed that the mean total and daily fecundity were significantly higher on 029 cultivars (96.25 and 5.79 eggs, respectively) followed by Markez cultivars (70.80 and 5.00 eggs, respectively) compared to those maintained on Fortona (51.80 and 4.38 eggs, respectively) or Wanter star (37.61 and 3.42 eggs, respectively) (P = 0.0001) cultivars. The sex ratio of TSSM offspring was with a proportion of females ranging from 67.91 to 76.18 %.

Means and standard errors of the life table parameters of *T. urticae* (estimated by the bootstrap techniques) on four cultivars of strawberry are displayed in Table 4.

Table 2. Biological parameter (± SE) of *Tetranychus urticae* female reared on four strawberry cultivars.

Biological parameters (day)	Strawberry cultivars			
	029	**Fortona**	**Markez**	**Wanter star**
Pre-oviposition	1.31±0.13a	1.08±0.13b	1.60±0.16a	1.39±0.15a
Oviposition	16.63±0.53a	11.84±0.42c	14.17±0.48b	11.00±0.39c
Post-oviposition	2.38±0.24a	2.44±0.22a	1.97±0.18a	2.09±0.15a
Female longevity	20.31±0.30a	15.36±0.41c	17.73±0.33b	14.48±0.31c
Life span	31.06±0.35a	27.44±0.53b	28.40±0.47b	27.35±0.49b

The means in each row with the same letters are not significantly different (Paired bootstrap test, $P \leq 0.05$).

Table 3. Mean oviposition (± SE), sex ratio and egg hatchability (%) of *Tetranychus urticae* reared on four strawberry cultivars.

	Strawberry cultivars			
	029	**Fortona**	**Markez**	**Wanter star**
Total fecundity	96.25±1.53 a	51.80±1.42 c	70.80±1.08 b	37.61±0.96 d
Daily fecundity	5.79±0.19 a	4.38±0.09 c	5.00±0.21 b	3.42±0.10 d
Sex ratio (females/ total) (%)	76.18	72.75	71.56	67.91
Egg hatchability (%)	89.42	82.47	91.71	86.82

Means followed by the same letter within rows are not significantly different (Paired bootstrap test, $P \leq 0.05$).

Table 4. Life table parameters (mean ± SE) of *Tetranychus urticae* reared on four strawberry cultivars.

Life table parameters	Strawberry cultivars			
	029 (32)	**Fortona** (25)	**Markez** (30)	**Wanter star** (23)
Intrinsic rate of increase (*r*)	0.264±0.001a	0.227±0.002c	0.257±0.001b	0.194±0.001d
Finite rate of increase (λ)	1.302±0.001a	1.255±0.002c	1.293±0.002b	1.214±0.002d
Net reproductive rate (R_0)	75.446±0.986a	34.489±0.623c	52.960±0.723b	25.642±0.417d
Mean generation time (*T*)	16.358±0.039b	15.579±0.064c	15.434±0.056c	16.707±0.080a
Gross reproductive rate (*GRR*)	77.294±0.990a	35.902±0.585c	54.090±0.712b	28.034±0.403d

Data in each cultivar is related to the age-stage, two-sex life table.
Numbers in parentheses represent the number of replicates.
Mean values in a row followed by different letters are significantly different (Paired bootstrap test, $P \leq 0.05$).

Age-specific survivorship, age and age-stage-specific fecundity

The age-specific survivorship (l_x) and age-specific fecundity (m_x) of TSSM reared on different strawberry cultivars are shown in Figure 2. These curves indicate that *T. urticae* completed its development and reproduced on all tested cultivars. The mean number of offspring produced by the TSSM individuals of the age x and stage j per day is shown with the age-stage-specific fecundity (f_{xj}) in Figure 2. The start of oviposition of the first female on 029, Fortona, Markez and Wanter star occurred at the age 8, 9, 8 and 10 days, respectively. The highest daily fecundity (peak of f (i, female) of the TSSM on the above-mentioned cultivars was 8.06, 6.81, 7.07 and 5.00 eggs, respectively, that occurred at the age of 16, 12, 15 and 12 days, respectively.

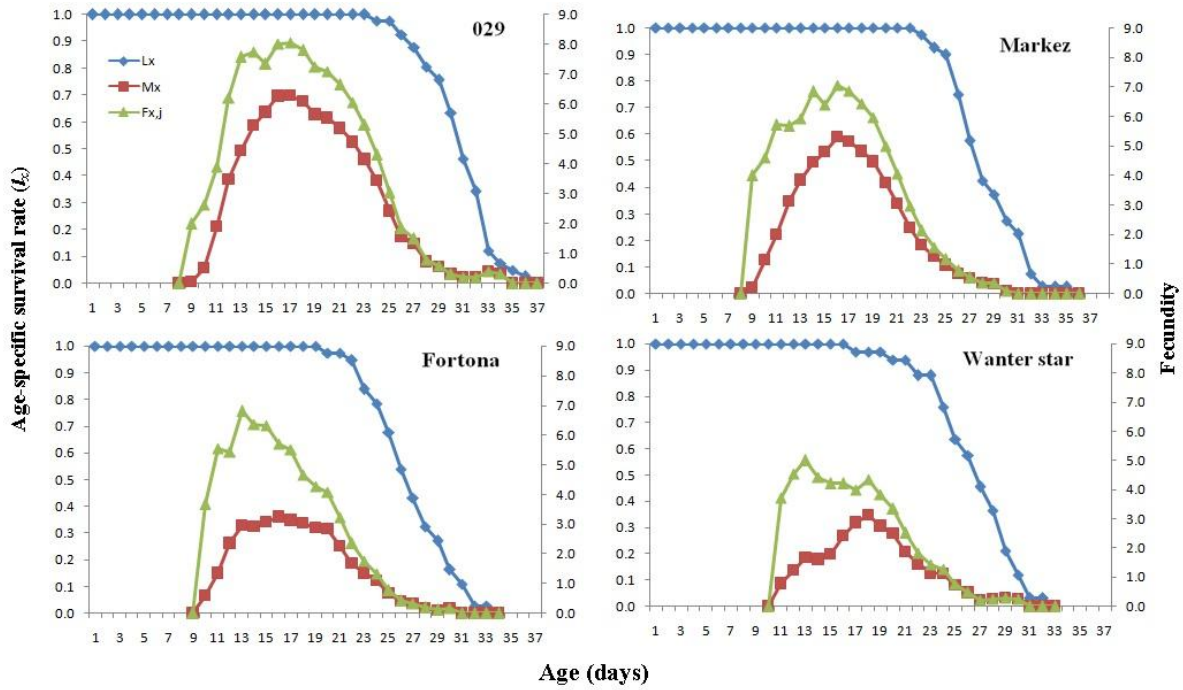

Figure 2. Age-specific survival rate (l_x), age-stage fecundity of female (f_{xj}) and age-specific fecundity rate (m_x) of *Tetranychus urticae* on four strawberry cultivars.

Two-sex life table parameters

Based on the age-stage, two-sex life table, for all the measured parameters: net reproductive rate (R_0), intrinsic rate of increase (r), mean generation time (T), finite rate of increase (λ), gross reproductive rate (GRR), significant differences were observed among the tested cultivars ($P < 0.05$). The results showed that the values of R_0, r, λ and GRR were significantly highest on 029 and lowest on Wanter star (Table 4). Mean generation time (T) was significantly shorter on Fortona and Markez versus the other cultivars.

Age-stage reproductive value

The age-stage reproductive value (v_{xj}) is the contribution of individuals of age x and stage j to the future population. The reproductive value for a new egg (v_{01}) of the TSSM on different strawberry cultivars is the finite rate of increase (λ) (Fig. 3, Table 4). The peak reproductive value of TSSM (Fig. 3) was at the age of 12, 10, 12 and 11 days on the above-mentioned cultivars, respectively. This implies that, in comparison with other ages, female individuals of the ages 12, 10, 12 and 11 days made the highest contribution to the population when reared on the above-mentioned cultivars, respectively.

Female age-specific life table

The traditional female age-specific life table, we constructed lx and mx (Fig. 4) according to the procedures described in the section of female age-specific life table.

The highest daily fecundity (peak of mx) of TSSM on 029, Fortona, Markez and Wanter star cultivars was 6.29, 3.24, 5.30 and 3.13 female offspring, respectively, that occurred at the age of 17, 16, 16 and 18 days, respectively.

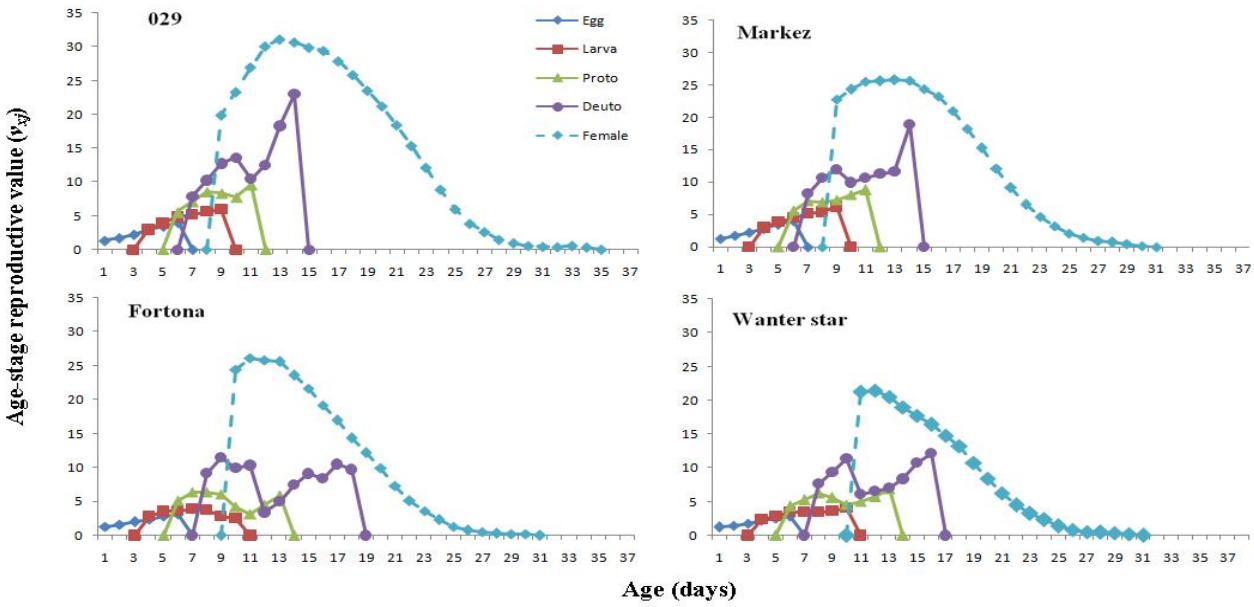

Figure 3. Age-stage reproductive value (v_{xj}) of *Tetranychus urticae* on four strawberry cultivars.

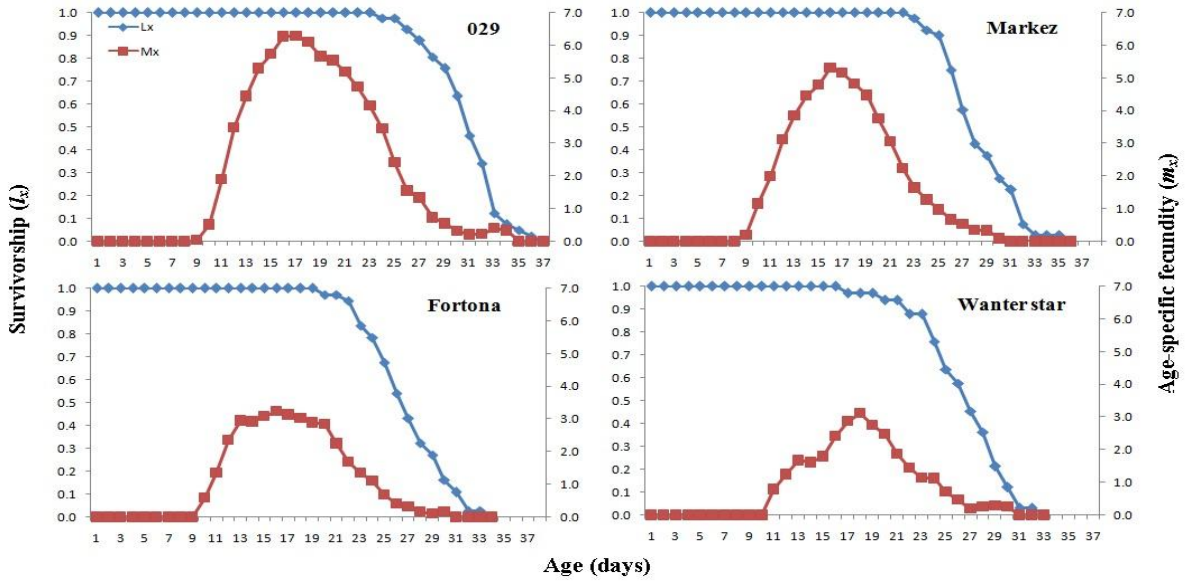

Figure 4. Age-specific survivorship (l_x), and fecundity (m_x) of *Tetranychus urticae* on four strawberry cultivars.

DISCUSSION

The present study revealed that there are significant differences in performance of the TSSM on four different strawberry cultivars. Tested cultivars had notable effects on all biological parameters of *T. urticae* (R_0, r, λ, T and GRR) ($P < 0.05$). The 029 cultivar is assumed to be the most appropriate one for rearing *T. urticae*, due to shorter generation time, higher fecundity and intrinsic natural increase than other ones.

Developmental periods of *T. urticae* females in this study ranged from 10.67 to 12.87 days. These results are comparable with Golizadeh *et al.* (2017) on 10 rose cultivars. On all tested strawberry cultivars, the pre- and post-oviposition periods were much shorter than oviposition period. The longer reproductive periods of *T. urticae* are favorablein making the mite able to

reproduce more eggs. These results are similar to other reports on *T. urticae* (Sedaratian *et al*. 2011; Khanamani *et al*. 2013; Maleknia *et al*. 2016).

The higher fecundity on 029 cultivar suggested that the quality and/or quantity of its nutrients were more suitable for TSSM than the other tested cultivars.

The oviposition rate of *T. urticae* on four strawberry cultivars ranged from 37.61 to 96.25 eggs/ female. Some works demonstrated various fecundity rates of TSSM on other plants for example: 5.98–104.85 eggs/female on cucumber (Ullah *et al.* 2006), 33.62–153.22 eggs/ female on 14 soybean genotypes (Sedaratian *et al*. 2009), 82.45–142.05 eggs/female on seven bean cultivars (Najafabadi 2012) and 5.25–29.23 eggs/female on seven eggplant cultivars (Khanamani *et al*. 2013). Such different numbers can be attributed to the variations in quality and quantity of nutrients and secondary substances in the tested host plants and leaf structure (Agrawal 2000; Dicke 2000).

Our results showed that tested strawberry cultivars significantly influenced the life table parameters of TSSM (Table 4). Presently, the values of R_0 were ranged from 25.642 offspring/ individual on Wanter star to 75.446 offspring/individual on 029. Our results showed that the R_0 value of TSSM on strawberry cultivars was higher than those reported by Khanamani *et al*. (2013) on eggplant (1.5 to 11.1 offspring/individual), Rezaie *et al*. (2013) on strawberry cultivars (6.16 to 25.08 offspring/individual) and Karlec *et al*. (2016) on 16 cultivars of strawberry (1.96 to 14.84 offspring/individual). Various food sources taken up by TSSM during its life span could be a reliable cause for such differences. In addition, the R_0 value for TSSM in the present study was comparable to that reported by Maleknia *et al*. (2016) on cucumber 43.38 to 75.70 offspring/individual and Golizadeh *et al*. (2017) on roses from 34.05 to 47.64 offspring/individual.

Presently, the r values ranged from 0.264 to 0.194 (day^{-1}). Our results revealed that Wanter star is an unsuitable cultivar for the growth and development of TSSM. Ahmadi *et al*. (2007) reported r values ranging from 0.142 to 0.038 (day^{-1}) on common bean, Khanamani *et al.* (2013) estimated values of r to range from 0.166 to 0.031 (day^{-1}) on eggplant, and Golizadeh *et al*. (2017) found values of 0.253 to 0.169 (day^{-1}) on various rose cultivars. Among other strawberry cultivars, Rezaie *et al*. (2013) mentioned r values from 0.17 to 0.28 (day^{-1}) while Karlec *et al*. (2016) reported values from 0.120 to 0.30 (day^{-1}). The lower values of r and R_0 of *T. urticae* indicate the resistance of the host plants to the mite pest attacks, while higher values of these parameters reveal that the host plant is susceptible to the phytophagous pests.

Both R_0 and r values are significant indicators of the population dynamics of mite pests (Sabelis 1985; Krips *et al*. 1998). However, comparisons of R_0 and r commonly give great insight beyond the parameters of life history (Zhang *et al.* 2007). The lowest value of r on Wanter star cultivar was related to the longer development of immature stages and lower fecundity of the TSSM on this cultivar than other ones. The lower value of net reproductive rate of TSSM population and longer generation time are directly responsible for the lower value of intrinsic rate of the population increase on Wanter star. The lower values of (R_0, r, λ and *GRR*) on Wanter star indicate that this host plant is more resistant to *T. urticae* than others.

Trichomes have been reported to be involved in protection against arthropod attacks and extreme climatic conditions (Kang *et al*. 2010). Strawberry plants have two types of trichomes, non-glandular and glandular (Steinite and Ievinsh 2003). The non-glandular trichomes are not the resistance factor for strawberry cultivars against spider mites (Steinite and Ievinsh 2002, 2003). Glandular trichomes-borne metabolites (2-tridecanone, 2- undecanone, other methyle ketones, zingiberene) that are released when the mites/insects come in contact with trichomes, and may have toxic effects on various herbivores (Kang *et al*. 2010). These substances act as physical and chemical barriers against mite/insect feeding process and indirectly affect their oviposition (Steinite and Ievinsh 2002).

The life history and oviposition rate of *T. urticae* could be affected by leaf characteristics of the host plants and play a role in the direct defense against the pest (Peters and Berry 1980; Sabelis 1981). Afifi *et al*. (2010) revealed that the higher density, longer and sharper leaf trichome of Sweet

Charlie than Camerosa (both strawberry cultivars) lead to the latter cultivar being more susceptible to infestation by *T. urticae*. Goncalves *et al*. (2006) and Figueiredo *et al*. (2010) indicated that trichoma's (glandular and/or non-glandular) may have an effect on *T. urticae* survival, either by producing sticky materials that limit their movement or by toxic influence on the mites.

CONCLUSION

In Egypt, we suggest that the cultivars 029 and Markes can be replaced by the other ones in a strawberry field in order to obtain better results in the control of *T. urticae*. The information presented in the current study is also beneficial at field scale for strawberry growers. Hence, the use of resistant strawberry cultivars together with other methods of control such as biological control agents can decrease the use of the chemical acaricides in the control of TSSM on strawberry plants.

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فراسنجه‌های جدول زیستی *Tetranychus urticae* (Trombidiformes: Tetranychidae) روی چهار رقم توت‌فرنگی

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چکیده

کنهٔ تارتن دو لکه‌ای، *Tetranychus urticae* Koch یکی از مهم‌ترین آفات گیاهان توت‌فرنگی در سراسر جهان است. این مقاله زیست‌شناسی و فراسنجه‌های جدول زیستی کنهٔ تارتن دو لکه‌ای را روی چهار رقم توت‌فرنگی شامل ونتر استار، مرکز، فورتونا و ۰۲۹ در شرایط آزمایشگاهی مقایسه می‌کند. زمان نمو ماده‌ها روی رقم‌ها اختلاف معنی‌داری نشان داد در حالی که چنین اختلافی برای نرها دیده نشد. زمان نمو روی رقم‌های ونتر استار و فورتونا در مقایسه با دیگر رقم‌ها طولانی‌تر بود (P = ۰/۰۰). ماده‌های کنهٔ تارتن دو لکه‌ای کوتاه‌ترین دورهٔ تخمگذاری و طول عمر کنه‌های کامل را روی رقم‌های فوتونا و ونتر استار نشان دادند در حالی که بلندترین این دوره‌ها روی رقم ۰۲۹ اتفاق افتاد (P = ۰/۰۰). کم‌ترین بارآوری و تخم روزانه روی رقم ونتر استار ثبت شد. بیشترین میزان باروری روی رقم ۰۲۹ در مقایسه با دیگر رقم‌ها ثبت شد؛ بنابراین ونتر استار به عنوان رقمی مقاوم در برابر آلودگی به کنهٔ تارتن دو لکه‌ای معرفی می‌شود.

واژگان کلیدی: زیررده کنه‌ها؛ دورهٔ زندگی؛ تیرهٔ گل‌سرخیان؛ Tetranychoidea؛ کنهٔ تارتن دو لکه‌ای.

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