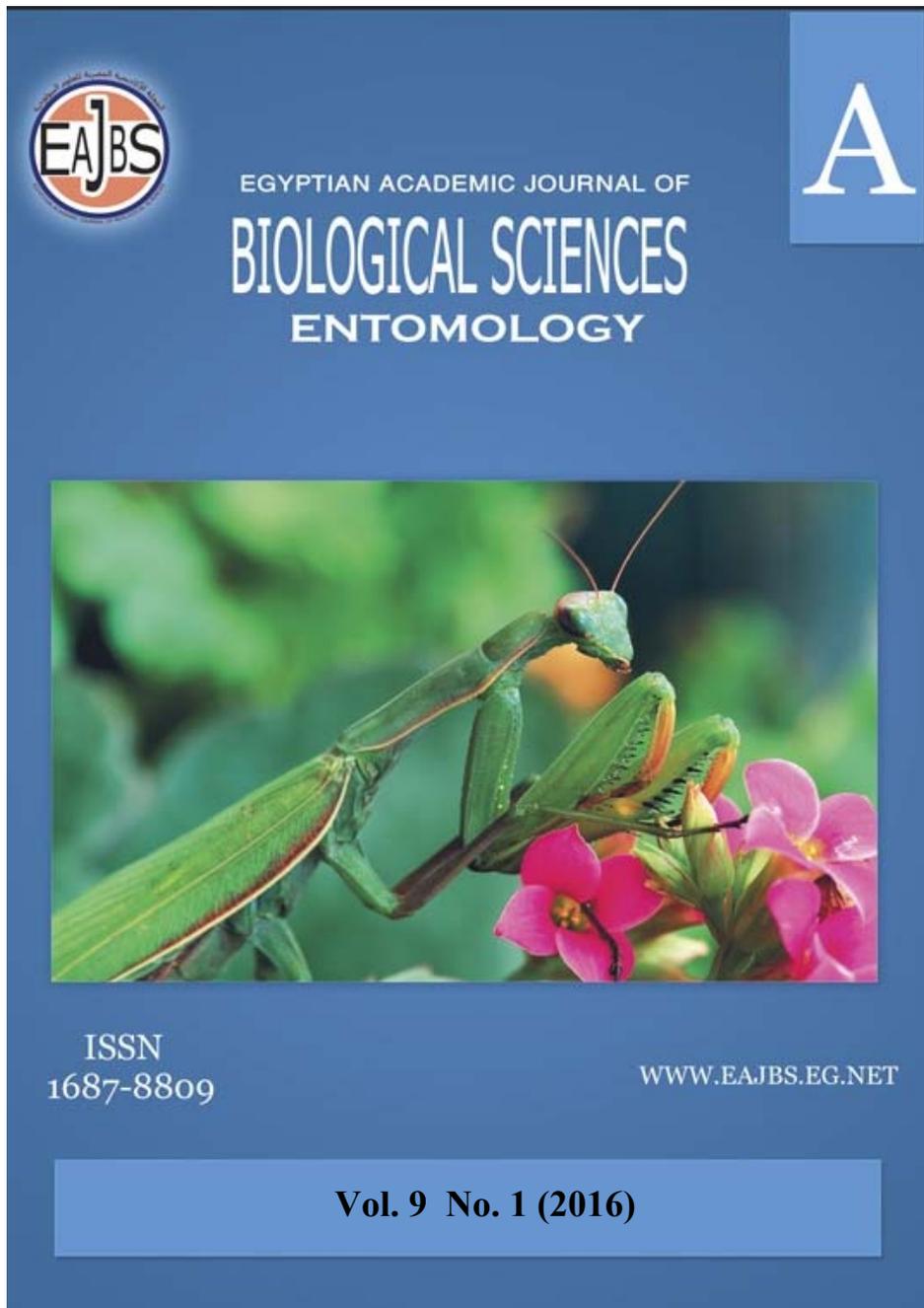


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Seasonal dynamics of the two spotted red spider mite, *Tetranychus urticae* Koch on two field crops in Qalubia governorate, Egypt.

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ABSTRACT

The seasonal dynamics of *Tetranychus urticae* Koch on clover and cotton crops were investigated at Qaha research Station, Qalubia governorate, Egypt during two successive years, 2013 and 2014. Infestation of clover and cotton started in January and June, respectively. The monthly collected number and percent occurrence of eggs and most movable life stages gradually increased to reach peaks in March and September then decreased in next month(s) at the end of the season of each clover and cotton, respectively. Eggs were the most abundant life stage of the total stages collected in each month and adult females predominated males and most other movable life stages monthly collected throughout the clover and cotton season in each year. Generally, the annual number of each life stage of *T. urticae* infested each of the clover and cotton was higher in 2014 than 2013 and on clover than cotton in each year.

Laboratory rearing of *T. urticae* on leaf discs of each clover and cotton at three different temperatures (15, 25 and 35°C) and a relative humidity of 69±10 % showed that change of temperatures greatly affected development and reproduction of this mite. At 15°C, no eggs were laid and development of the whole life cycle was arrested. However, development from egg to adult was accelerated by increasing temperature from 25 to 35°C which shortened the durations of development of immature stages, life cycle, adult female reproductive period (longevity) and life span. Fecundity and fertility were higher at 25°C than 35°C on each of clover and cotton and were the highest on clover at 25°C.

INTRODUCTION

The two spotted red spider mite, *Tetranychus urticae* Koch is a temperate zone mite species of a worldwide distribution in tropical, subtropical regions and in green houses (Fasulo and Denmark, 2009). In Egypt, *T. urticae* infests almost all field crops, several vegetables, some fruits and ornamentals (Ahmed, 1988; Skirvinet *al.*, 1999; Salman, 2007 and Amal, 2008). It feeds on the green epidermal cells of the plant leaves and sucks the cell contents causing pale spots or lesions where the cells are destroyed and thus the photosynthetic ability and nutrients production of the plant are reduced. This may lead to withering, complete defoliation and even killing of the host plant, which reduces yield of the crop (Smiley and Ochoa, 2008).

In Egypt clover (*Trifolium alexandrium*) and cotton (*Gossypium barbadense*) are two economically field crops which are used as fodder of cattles and domestic animals and in the industry of cloth, respectively. Several ecological and biological studies have been carried out on *T. urticae* infestation of cotton but not on clover crop in different countries including Egypt (Cividanset *al.*, 1990; Taha *et al.*, 1990; Wilson and Morton, 1993; Mohammed *et al.*, 2002; Abdallah and Kellany, 2003; Farnenet *al.*, 2004; Forghani and Honapavar, 2009).

The present study investigates the seasonal dynamics of *T. urticae* on each of clover and cotton crop at Qaha research station, Qalubya governorate during two successive years 2013 and 2014. Also, biological studies on development and reproduction are carried out by laboratory rearing of *T. urticae* on each clover and cotton leaf discs at 3 different temperatures (15, 25 & 35°C).

MATERIALS AND METHODS

Ecological studies:

The seasonal dynamics of *Tetranychus urtica* stages on cotton and clover crops at Qaha Station, Qalubya governorate, Egypt were collected bi-weekly during two successive years 2013 and 2014.

The prevailed ambient temperature and relative humidity every month were obtained from the meteorological station in the form of maximum, minimum and average monthly temperature and relative humidity. (Ibraheem, 2016).

Collection method of two spotted spider mite, *Tetranychus urticae*:

Spider mite populations which were found on leaf samples of clover and cotton were periodically picked up at random from 10-20 plants in the experimental location. The experimental plot for this study was clean non insecticides sprayed area of 7m x6m.

Samples were from the three levels of the plants (upper, middle and lower parts). After being picked up, sample of host plant leaves are placed separately labelled in paper bags, tightly closed and transferred to the laboratory.

The collected samples of the two spotted spider mite were identified and sorted to the stage, sex and counted bi-weekly for each stage on each plant using stereoscopic binocular microscope. (Zaher, 1984).

Biological studies:

Mite colony:

Adults of *Tetranychus urticae* were used to establish the laboratory colonies as described by Amal, (2008). Two colonies on two selected host plants (cotton and clover) were established and maintained at 3 different temperatures 15, 25 and 35°C and 69±10 % RH.

Bottom of 9 cm in diameter petri-dish was fitted with a disc of plastic foam, saturated with water. A plant leaf of each plant (cotton and clover) was placed (upper surface down) on the saturated plastic foam. The leaf emerged on wetted cotton in the plastic foam. The leaf edges were surrounded with strips of filter paper as water barrier.

For biological studies ten circles of 1 cm in diameter of each plant were placed with the lower surface down in the petri-dishes.

After three days, the leaf circles were gently removed and replaced by fresh leaves. The water added when needed to keep the humidity high. The mite developmental period from egg to adult, sex ratio, longevity, fecundity and fertility of adults are studied for mites reared on each plant (Zhang, 2003).

Statistical analysis:

The obtained results from seasonal dynamics of *Tetranychus urticae* on the clover and cotton crop were analyzed by statistical package of Social Science (SPSS), version 20 for windows.

In the experiments of the biological studies of female *Tetranychus urticae* at 3 different temperatures on clover and cotton leaves. The data were subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 level, using SAS program.

RESULTS

Seasonal dynamics of *T. urticae* on clover crop:

Infestation of the clover crop at Qaha research Station in Qalubya governorate started in January 2013 and 2014 when most life stages including eggs, larvae, nymphs and adult females were observed on the plant leaves, in the fourth week of this month. The monthly collected numbers and percent abundance of eggs and most movable life stages were the lowest in January and gradually increased ($p < 0.05$) to reach their peaks in March, then decreased in next months (Fig. 1.a & 1.b). In March, eggs and the total movable life stages constituted 34.5 & 34.04% and 36.8 & 31.9% of the corresponding total numbers collected during the clover season 2013 and 2014, respectively. In both years, eggs were the most abundant life stage ($p < 0.05$) in each month throughout the clover season (Fig. 1.a & 1.b) and constituted 78.95% and 78.32% of the total number of the life stages collected (133 & 143) in March 2013 and 2014, respectively.

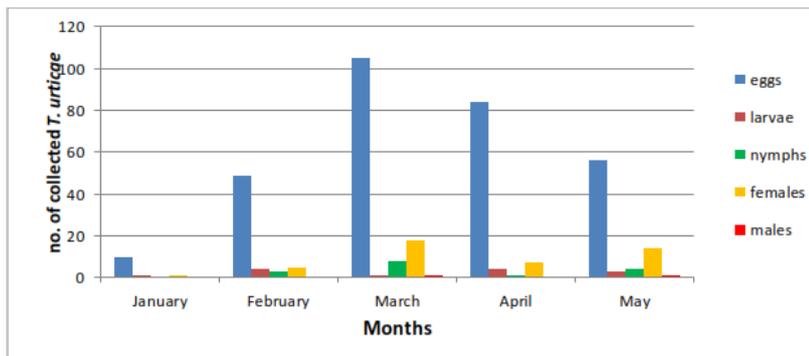


Fig. (1.a): Seasonal dynamics of *Tetranychus urticae* infesting the clover crop during 2013 at Qaha Station, Qalubya Governorate.

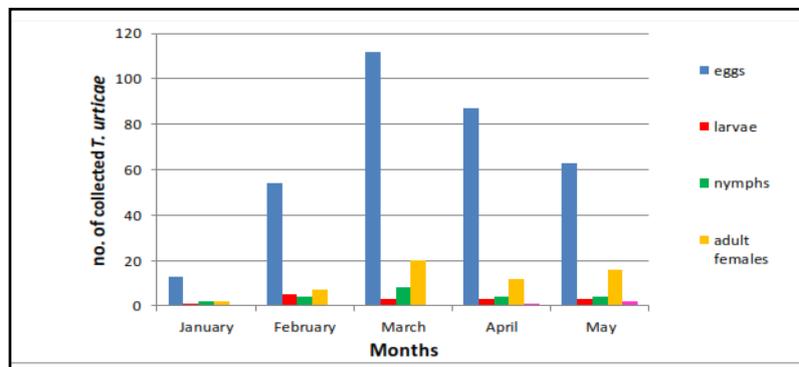


Fig. (1.b): Seasonal dynamics of *Tetranychus urticae* infesting the clover crop during 2014 at Qaha Station, Qalubya Governorate.

Also, females predominated males and almost all other movable life stages ($p < 0.05$) collected in each month of the clover season and constituted 64.29 and 64.52% of the total number of movable life stages collected (28 & 31) in March 2013 and 2014, respectively. Generally, the annual number of each life stage of *T. urticae* infested clover was higher in 2014 than 2013. The annual numbers collected were 304 & 329 eggs, 76 & 97 movable life stages and 380 & 426 total of all life stages in 2013 and 2104, respectively.

Seasonal dynamics of *T. urticae* on cotton crop:

Infestation of the cotton crop at Qaha research Station in Qalubia governorate started at the fourth week of June 2013 and 2014 when most of the life stages of *T. urticae* were observed on the plant leaves. The monthly collected numbers and percent abundance of eggs and most movable life stages gradually increased ($p < 0.05$) to reach their peaks in September, then decreased in October at the end of the cotton season (Fig. 2.a & 2.b). In September, eggs and the total movable life stages constituted 41.67 & 42.86% and 45.9 & 43.04% of the corresponding total numbers collected during the cotton season 2013 and 2014, respectively. In both years, eggs were the most abundant life stage ($p < 0.05$) in each month throughout the cotton season (Fig. 2.a & 2.b) and constituted 71.43 and 70.43% of the total number of the life stages collected (98 & 115) in September 2013 and 2014, respectively. Also, females predominated males and almost all other movable life stages ($p < 0.05$) collected in each month of the cotton season and constituted 60.71 and 50% of the total number of movable life stages collected (28 & 34) in September 2013 and 2014, respectively.

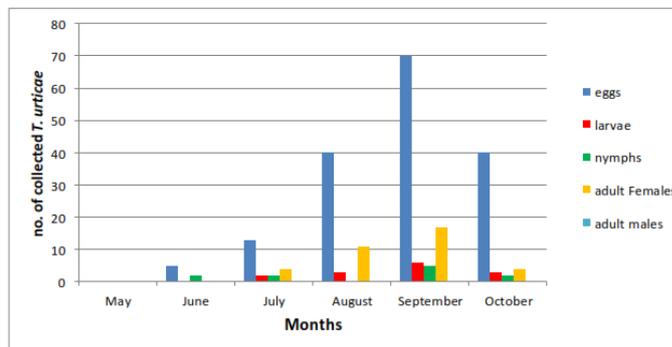


Fig. (2.a): Seasonal dynamics of *Tetranychus urticae* infesting the cotton crop during 2013 at Qaha Station, Qalubia Governorate.

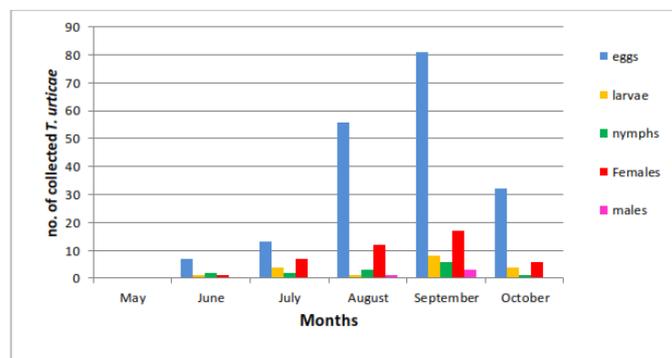


Fig. (2.b): Seasonal dynamics of *Tetranychus urticae* infesting the cotton crop during 2014 at Qaha Station, Qalubia Governorate.

Generally, the annual number of each life stage of *T. urticae* infested cotton was higher in 2014 than 2013. The annual numbers collected were 168 & 189 eggs, 61 & 79 movable life stages and 229 & 268 total of all life stages in 2013 and 2104, respectively.

Effect of temperature and host plant on development and reproduction of *T. urticae*:

Laboratory rearing of *T. urticae* on each of clover and cotton leaf discs at three different temperatures (15, 25 and 35°C) and a relative humidity of 69±10 % showed that no eggs were laid by the female at 15°C and therefore development of the whole life cycle was arrested. However, the mite was able to lay eggs and to complete its life cycle at 25 and 35°C (Figs. 3-8). Developmental period of immature life cycle (egg incubation plus total immature periods) and adult female reproductive period or longevity (specially during oviposition) and life span (immatures life cycle plus female longevity) were shortened ($p < 0.0001$ - $p < 0.05$) by increasing the temperature from 25 to 35°C. Durations of the immatures life cycle was shortened ($p < 0.001$) from 7.9±0.58 and 7.3±0.33 days at 25°C to reach 6.5±0.33 and 6.4±0.33 days on clover and cotton, respectively (Figs. 3&4).

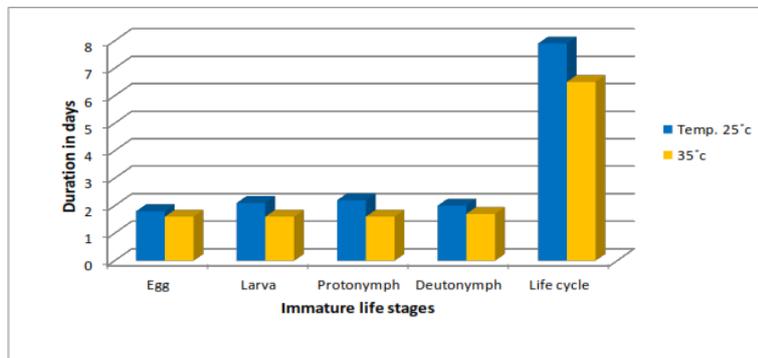


Fig. 3: Duration of development of immature stages of *Tetranychus urticae* reared on leaves of clover at 25°C and 35°C.

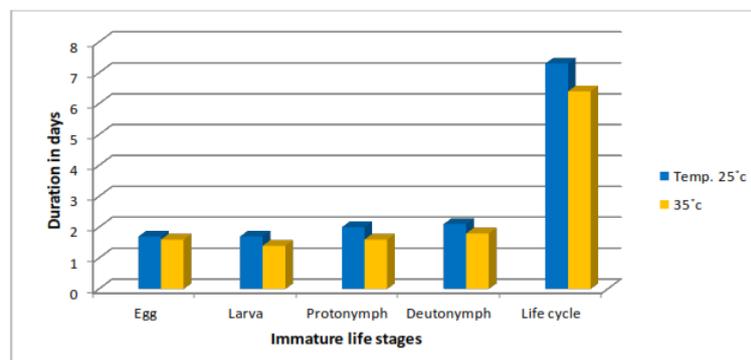


Fig. 4: Duration of development of immature stages of *Tetranychus urticae* reared on leaves of cotton at 25°C and 35°C.

Similarly, the female reproductive period or longevity (Figs. 5 & 6) and life span on clover were shortened ($p < 0.001$) from 11.11±1 and 19.1±0.33 days at 25°C to reach 8.2±0.58 and 14.7±0.88 days at 35°C, respectively. On cotton the adult female longevity and life span were shortened ($p < 0.001$) from 9.7±0.88 and 17.6±1.2 days at 25°C to reach 7.4±0.88 and 13.8±1.2 days at 35°C, respectively. Fecundity and fertility (Figs. 7 & 8) were higher ($p < 0.0001$) at 25°C on each of clover (31.9±3.38 egg/female & 69.3±2.6 %) and cotton (26.9±0.33 eggs/female & 65.4±1.45%) than at 35°C where the two

parameters decreased to 14.4 ± 2.52 egg/female & $60.4 \pm 2.0\%$, respectively on clover and 16.8 ± 0.88 eggs/female & $63 \pm 1.2\%$ on cotton. However, each of fecundity and fertility were the highest ($p < 0.05$) on clover at 25°C . The mean number of adult progeny were higher at 25°C (7 ± 0.88 & 6.2 ± 0.88) than 35°C (3.8 ± 0.33 & 3.9 ± 1.33) on clover and cotton, respectively and sex ratio ranged from 1:12 to 1:18 male to female.

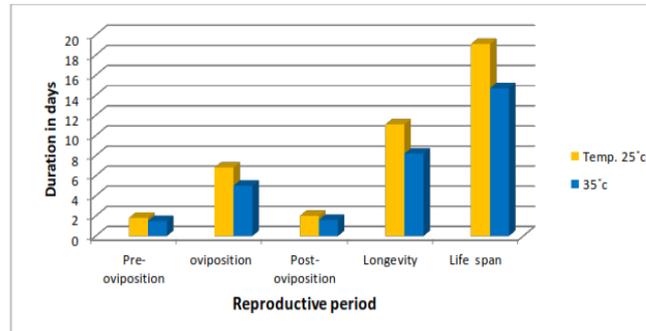


Fig. 5: Duration of the reproductive period (longevity) and life span of *Tetranychus urticae* reared on leaves of clover 25°C and 35°C .

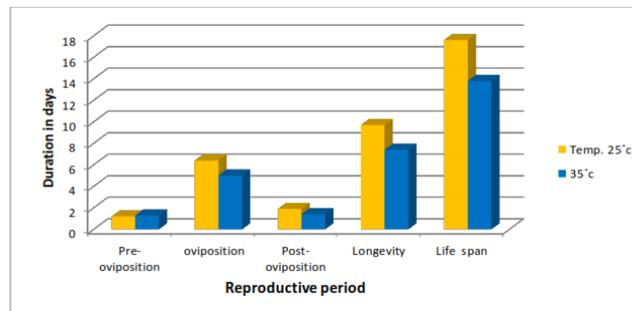


Fig. 6: Duration of the reproductive period (longevity) and life span of *Tetranychus urticae* reared on leaves of cotton at 25°C and 35°C .

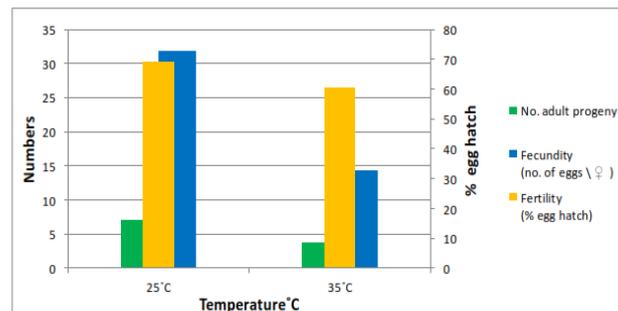


Fig. 7: Adult progeny, female fecundity and fertility of *Tetranychus urticae* reared on leaves of clover at 25°C and 35°C .

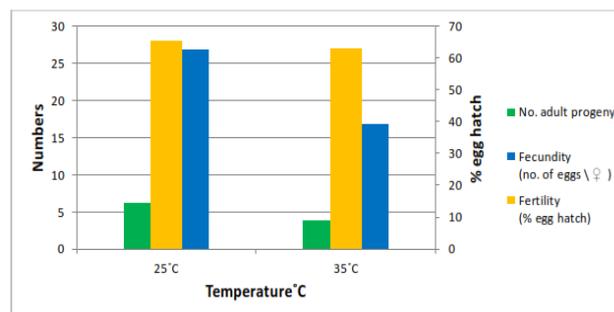


Fig. 8: Adult progeny, female fecundity and fertility of *Tetranychus urticae* reared on leaves of cotton at 25°C and 35°C .

DISCUSSION

Ecological studies:

Tetranychus urticae is one of the most common acarine pests infesting almost all field crops in Egypt including cotton and clover (Ismail, 1963). Several ecological and biological studies have been conducted on cotton crop infestation by *T. urticae* in Egypt (Ali, 2002; Abdalla & Kellany, 2003 and Amal, 2008). However, in spite of the economic importance of clover as a food of farm animals in Egypt and as a host plant and a source of *T. urticae* which is directly cultivated before cotton in the same fields, no previous studies were conducted on clover or attempted to clarify the ecological interrelationships between the mite infestation and the two crops. The present study investigated the seasonal dynamics of *T. urticae* on each of clover and cotton crop at Qaha research Station, Qalubia governorate during two successive years, 2013 and 2014. Results of the present study revealed that infestation on clover and cotton started with low incidence in winter (January) and summer (June), gradually increased to reach peaks in early spring (March) and fall (September), respectively, when mild mean temperatures of 20.29- 27.95 were meteorologically recorded (Ibraheem, 2016). The cultivation of clover in winter to late spring (January - May) followed by cotton in early summer to fall (June-October) in the same locality allowed pest transmission between the two crops and maintenance of *T. urticae* infestation in the locality throughout the two years of study. The significance of these observations to integrated control of the pest needs further investigation.

Findings of the present study closely conform to those of Amal (2008) on cotton and broad bean crops in Qalubia and Benisueif governorates during two successive years from 2003 to 2005. She recorded that population density of *T. urticae* on broad bean was high in April and on cotton was high in August in Qalubia.

The peaks of monthly abundance of *T. urticae* on each of clover and cotton were followed by a decrease of the pest number at the end of the season of each crop. In both infested crops, eggs were the most abundant life stage of the total stages collected in each month and adult females predominated males and most movable life stages monthly collected. Generally the total annually collected number of eggs and most of the movable life stages of *T. urticae* infested each of clover and cotton crop were higher in 2014 than 2013 and on clover than on cotton in each year. This might have resulted from changes of temperatures, percent relative humidity or other environmental factors and even associated predators. Abd El-Mohsin (2011) reported that temperature & relative humidity positively affected population growth of *T. urticae* on watermelon cultivars during 2009 and 2010. Furthermore, he found that difference in plant leaves morphological structure and its chemical content may contribute to the increase of the annual number & percent of *T. urticae* collected on certain watermelon cultivars than the others.

Biological studies

The effect of temperature and the host plant quality on fitness of *T. urticae* was assessed by determining durations of developmental periods of immature life stages and adult female reproductive periods or longevity, life span and female fecundity and fertility of mites reared on leaf discs (Rao *et al.*, 1996) of clover and cotton at 3 different temperatures (15, 25 & 35°C) and one relative humidity (69±10%). Results of the present study showed that changes in temperature greatly affected development and reproduction of *T. urticae* on both tested host plants which agreed with findings of several investigators of *T. urticae* develop on cotton and other host plants (Ali,

2002 and Abd El-Mohsin, 2011). At the lowest tested temperature (15°C) no eggs were laid and development of the whole life cycle was arrested. At 25 and 35°C, the laid eggs were hatched into larvae which developed into pro-, deuto-nymph then adult male and females as was found in all studied mites of family Tetranychidae (Krantz, 1978, Metcalf & Metcalf, 1993) on both clover and cotton development of *T. urticae* from egg to adult was accelerated by increasing the temperature from 25 to 35°C which shortened the duration of the immatures life cycle (egg incubation plus total immature periods). Also, the increase of temperature from 25 to 35°C shortened the duration of the adult female reproductive period (longevity) and life span. Fecundity, fertility and the number of adult progeny were higher at 25 than 35°C on each of clover and cotton. Similar effects of the increase in temperature on acceleration of development and decrease of net female reproduction have been recorded in *T. urticae* on cotton at different temperatures (Ali, 2002) or on different host plants (Abd El-Mohsin, 2011 and Ali, 2013) or in closely related Tetranychid species (ShaefUllah, 2012). Ali (2002), studied the development of *T. urticae* at 20, 24 & 28°C on cotton and found that egg incubation and immatures development was shortened and female longevity was decreased by increasing temperature from 20 to 28°C and fecundity was the highest at 24°C. Ali (2002), suggested temperatures between 24 & 28°C to be most favourable to *T. Urticae* development. ShaefUllah (2012) investigated the effect of 11 temperatures on *T. macfarlanei* on the kidney beans and found that temperature range of 17.5 to 37.5°C was suitable for this mite to lay eggs and complete life cycle where development was the slowest at 17.5°C and the fastest at 35°C for both male and female while the net reproductive rate (no. of females/ female) was the highest at 25°C.

In the present study the effect of the host plant quality was more apparent on adult female longevity and life span which were longer for *T. urticae* reared on clover than on cotton at each tested temperature (25 & 35°C). Also, host plant affected female fecundity and fertility which were higher on clover than cotton at the mild temperature of 25°C. The observed effects might have resulted from difference in host plant leaf morphological structure and its chemical contents. Abd El-Mohsin (2011) and Ali (2013) found that susceptibility of watermelon and sweet pepper cultivars, respectively to infestation with *T. urticae* increased as the number of trichomes/ Cm² of the host plant cultivars decreased. Positive relationships were found between *T. urticae* infestation level and total amino acids and sugars in the plant cultivars and negative relationship shown with tannins and phenolic compounds.

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ARABIC SUMMERY

على نخيل التذبذبات الموسمية للعنكبوت الأحمر ذو البقعتين تيترانيكساورتিকা على محصولين بمحافظة القليوبية في مصر.

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2- قسم اكاروس القطن والمحاصيل – معهد بحوث وقاية النبات مركز البحوث الزراعي.

تمت دراسة التذبذبات الموسمية للعنكبوت الأحمر ذو البقعتين تيترانيكساورتিকা على محصولي البرسيم و القطن في محطة بحوث قها بمحافظة القليوبية في مصر على مدار سنتين متتاليتين 2013 و 2014 وقد بدأت إصابة محصولي البرسيم و القطن في شهر يناير و يونيه على التوالي و زادت أعداد و نسب البيض و الأطوار المتحركة تدريجيا حتى وصلت الى الذروه في شهر مارس و سبتمبر على التوالي ثم نقصت في الشهور التاليه حتى نهاية كل من موسم البرسيم و القطن .
وجد أن البيض هو الطور السائد بالنسبه لجميع الأطوار التي تم جمعها كل شهر وأن إناث الطور البالغ سادت على الذكور وباقي الأطوار المتحركة التي تم جمعها شهريا خلال موسمي البرسيم والقطن من كل عام. وكانت الأعداد السنويه التي تم جمعها للأطوار الحياتيه للأكاروس على كل من محصول البرسيم و القطن أعلى نسبيا في سنة 2014 عنها في سنة 2013 وكذلك الإصابة بالأكاروس في محصول البرسيم كانت أعلى من القطن في كل سنة.
أظهرت التربيه المعملية للعنكبوت الأحمر ذو البقعتين على أوراق كل من البرسيم و القطن في ثلاث درجات حراره مختلفه 15 و 25 و 35° مئوية ورطوبه نسبيه 69 ± 10% أن التغير في درجات الحراره له تأثير كبير على التطور والتكاثر في هذا الأكاروس، حيث أن في درجة حراره 15° مئوية لم يضع الأكاروس أي بيض وبالتالي فإن دورة الحياه توقفت بالكامل. وأن زيادة الحراره من 25 الى 35° مئوية أسرعت من التطور من طور البيضة الى الطور البالغ حيث قصرت مدة دورة الحياه للأطوار غير البالغه ومدة التكاثر وفترة عمر أنثى الأكاروس البالغه كما زاد عدد البيض ونسبة الفقس عند 25 عن 35° مئوية على كل من البرسيم والقطن وكانت الأعلى في أوراق البرسيم عند 25° مئوية.