

Effect of temperature degrees on the duration of the phytophagous mite, *Eutetranychus orientalis* complex (Klein) (Acari: Tetranychidae) when fed on green bean (*Phaseolus vulgaris* L.)

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ABSTRACT

Spider mites (Acari: Tetranychidae) are the most important phytophagous mite pests of agricultural crops over the worldwide. This study aims to study the effect of different temperature degrees on the developmental stages of the phytophagous mite *Eutetranychus orientalis* complex (Klein) on some vegetable crops and to predict the population according to the prevailing temperature. Development times of the *Eutetranychus orientalis* complex (Klein) were evaluated in the laboratory on excised leaf disc of (green bean) *Phaseolus vulgaris* L at various degrees of temperature (20, 25 and 30±2 °C) with 60±5% relative humidity (RH) under laboratory conditions. Total development times from egg to adult stage were 26.37±1.28 and 24.24±0.92 days at 20±2 °C, 21.25±1.23 and 18.99±1.28 days at 25±2 °C and 11.48±1.07 and 9.88±1.16 at 30±2 °C for female and male respectively. The pre-oviposition period, oviposition period and post-oviposition period were 4.96±1.44, 8.13±2.22 and 4.87±1.23 days at 20±2 °C, 1.46±0.35, 6.73±0.82 and 1.99±0.79 days at 25±2 °C and 1.04±0.27, 6.20±0.87 and 1.67±0.40 days respectively at 30±2 °C. Total eggs laid by mite were found to reach the maximum limit at 30±2 °C (22.60 ± 3.63 eggs/mite) followed by 25±2 °C (16.44 ± 3.87 eggs/mite) and 20±2 °C (3.14 ± 2.56 eggs/mite). In conclusion, the time required for female life cycle, longevity and life span was longer than the male at different tested temperature degrees and the differences were significant and the 20±2°C gave the longest life cycle, while the temperature of 30±2°C gave the shortest life cycle.

Keywords: Phytophagous mite; *Eutetranychus orientalis* Complex; Tetranychidae.

INTRODUCTION

Spider mites (Acari: Tetranychidae) are the most important phytophagous mite pests of agricultural crops over the worldwide, whose population outbreaks can cause serious damage and yield losses. Among them, the citrus brown mite, *Eutetranychus orientalis* (Klein), is especially significant as the most polyphagous species in field and greenhouses in the Middle East, Africa, and Asia. It represents a serious pest of a wide variety of agricultural, ornamental and medicinal plants (Rasmy, 1978; Dhooria, 1985; Gupta, 1985; Kandeel et al., 1986; Sewify and Mabrouk 1991; Sangeetha and Ramani, 2011; El-Sharabasy, 2015).

The oriental red mite, *E. orientalis* (Klein) (Acarina: Tetranychidae), is not only a principal pest of citrus, but also has been reported to attack a wide variety of other plants including *Albizia* spp. (Walter et al., 1995).

The infested leaves turn yellowish-brown, dry up and ultimately fall off. Mite infestation is usually seen on the upper surface of leaves, under heavy webs to which dust particles adhere.

The infested leaves also get crumpled. Web formation, adhered dust particles and continuous cell sap sucking badly affect the photosynthesis process, leading to retarded

growth and reduced vigour of the host plants (Yousef et al., 2006).

In Spain, *E. orientalis* was observed for the first time in Malaga province, from where it extended towards nearby areas. The primary host of *E. orientalis* is *Citrus* spp., although it can cause damages to more than 50 plant species, so it is one of the most important pests due to its great colonisation ability. Several phytosanitary treatments per year are usually required to control it (Jeepson, 1989; Walter et al., 1995; García, 2003).

This study aims to study the effect of different temperature degrees on the developmental stages of the phytophagous mite *Eutetranychus orientalis* complex (Klein) on some vegetable crops and to predict the population according to the prevailing temperature.

MATERIALS AND METHODS

In this study, we evaluated the effects of various degrees of temperature (20, 25 and 30±2 °C) with 60±5 % R.H on the duration of *E. orientalis* complex (Klein) reared on leaves of (green bean) *Phaseolus vulgaris* L.

P. vulgaris leaves cultures are prepared as follows; A young but full-grown primary vegetables leaf with a short piece of the petiole was pressed firmly, with the upper surface uppermost, on wad of wet cotton wool

contained in a tin foil-dish to prepare pure culture of the tested mite. All the leaves used for the experiments were collected and placed in water containing a drop of dish detergent, rinsed several times with water, and examined under a stereozoom microscope to assure that no other mites were present.

Leaf discs of 2.5 cm in diameter were put in tin foil-dishes (15 cm in depth and 20 cm in diameter) on a piece of cotton wool. Each disc was rounded with a layer of cotton wetted with water. Drops of water were daily added to maintain suitable moisture for the mite. Whenever, a leaf substrate began to deteriorate, it was replaced with another fresh one. Twenty discs of fresh leaves of vegetables leaf each foil-dish contained ten discs.

The adult females were put with adult males, and each pair was allowed 24 h for mating. Then the males were removed. Such females were allowed 24 h for egg laying, then removed to fresh leaves and so on to obtain larvae of known age. The observations were inspected twice daily and the duration of developmental stages including egg incubation, immature stages, life cycle, longevity and fecundity were recorded. The rearing experiment was carried at 20, 25 and 30±2°C. and 60±5 % R.H.

Statistical Analysis

Data was subjected to analysis of variance (ANOVA) using Completely Randomized Design (CRD). We compared the obtained mean values for developmental parameters on (green bean) *Phaseolus vulgaris* L. at three different temperature degrees (20, 25 and 30±2°C).

RESULTS

We studied the development of *Eutetranychus orientalis* complex (Klein) at 20, 25 and 30±2 °C, with 60±5% R.H. on leaves of (green bean) *P. vulgaris* L.

The eggs of *E. orientalis* complex (Klein) hatched after 9.34±0.24, 7.99±0.38 and 4.80±0.30 days at 20, 25 and 30±2°C. and 60±5% R.H., respectively for female (Figure 1), while it was 9.27±0.50, 7.67±0.40 and 4.34±0.33 days at 20, 25 and 30±2 °C with 60±5% R.H., on the same trend for male on (green bean) *P. vulgaris* L. leaves (Figure 2). There was significant difference between the tested temperature as shown in (Table 1).

The average period of active larva (Table (1), Figs. (1 and 2) lasted for 4.17±0.43, 3.90±0.36 and 1.56±0.27 days for female, while it was

3.89±0.41, 3.66±0.26 and 1.39±0.29 days for male at 20, 25 and 30±2 °C with 60±5% R.H., respectively.

The average period of quiescent stage lasted 2.31±0.53, 1.63±0.29 and 0.63±0.29 days for female and 2.10±0.35, 1.33±0.26 and 0.47±0.23 days for male at 20, 25 and 30±2 °C with 60±5% R.H., respectively. The total larval periods were 6.50±0.67, 5.53±0.59 and 2.19±0.43 days for female, while it was 5.99±0.61, 4.99±0.37 and 1.86±0.32 days for male at the same trend. The differences between the periods of larval stages were significant for all tested temperatures, the longest period was at 20±2 °C, while the shortest period was at 30±2 °C on (green bean) *P. vulgaris* L. leaves. (Table 1), and Figures 1 and 2).

The active female protonymph (Table 1) lasted for 2.63±0.42, 2.31±0.34 and 1.83±0.26 days, while the quiescent stage lasted for 1.89±0.33, 1.43±0.31 and 0.87±0.33 days at 20, 25 and 30±2°C with 60±5% R.H., respectively.

The active male protonymph lasted 2.36±0.36, 1.80±0.21 and 1.54±0.30 days while the quiescent stage lasted 1.49±0.49, 1.24±0.24 and 0.65±0.32 days at the same trend.

The total protonymphal period was 4.56±0.61, 3.74±0.48 and 2.70±0.51 days for female, while it was 3.84±0.68, 3.04±0.36 and 2.19±0.44 days for male at the same trend (Figures, 1 and 2).

The previous data show that there were significant differences between the effects of the three different temperatures on (green bean) *P. vulgaris* L. leaves on the protonymphal periods.

The active female deutonymph occupied 3.39±0.34, 2.30±0.28 and 1.04±0.31 days, while the quiescent stage occupied 2.50±0.27, 1.69±0.23 and 0.75±0.25 days at 20, 25 and 30±2°C and 60±5% R.H., but active male deutonymph occupied 2.89±0.41, 1.90±0.28 and 0.85±0.32 days; the quiescent stage lasted 1.99±0.50, 1.39±0.25 and 0.65±0.20 days at 20, 25 and 30±2°C and 60±5% R.H., respectively (Table 1), and Figures 1 and 2).

The total deutonymphal periods were 5.89±0.55, 3.99±0.32 and 1.79±0.50 days for female, while such periods were 4.88±0.72, 3.29±0.50 and 1.49±0.50 days for male at the same trend. The previous data show that there was significant difference among the tested temperatures.

The total female immature stage which included larval, protonymphal and deutonymphal stages lasted for 17.07±1.24,

13.26±0.98 and 6.68±0.85 days (Table 1), while those of male lasted 14.97±0.75, 11.32±1.00 and 5.55±0.99 days, at 20, 25 and 30±2 °C and 60±5% R.H., respectively Figs. (1 and 2).

In general, the time required for female immature stage was longer than that of male at different tested temperatures and the differences were significant as shown in (Table 1).

The period of life cycle of *E. orientalis* complex (Klein), which included incubation, larval, protonymphal and deutonymphal stages was completed in 26.37±1.28, 21.25±1.23 and 11.48±1.07 days for female, while it was 24.24±0.92, 18.99±1.28 and 9.88±1.16 days for male at 20, 25 and 30±2°C and 60±5% R.H. on (green bean) *Phaseolus vulgaris* L leaves, respectively.

In general, it can be concluded conclusion the 20±2 °C gave the longest life cycle and the differences among the three temperatures were highly significant (Table 1, and Figures 1 and 2).

The longevity period average (Table 1) lasted for 19.31±2.48, 10.18±1.44 and 8.91±0.84 days for female while it was 12.85±1.29, 6.02±0.66 and 4.75±0.65 days for male at 20, 25 and 30±2°C and 60±5% R.H., on (green bean) *P. vulgaris* L. leaves at the same trend.

The life span average (Table 1) which included the period of life cycle and longevity was 45.68±3.20, 31.43±2.18 and 20.39±1.36 days for female while it was 37.09±1.49, 25.01±0.90 and 14.64±1.22 days for male at 20, 25 and 30±2°C. and 60±5% R.H., when all the individual reread on the leaves of (green bean) *P. vulgaris* L. (Figures, 1 and 2).

In general, the time required for female life cycle, longevity and life span was longer than the male at different tested temperature degrees and the differences were significant as shown in Table 1).

The preoviposition, generation, oviposition and postoviposition period (Table 2, Figure, 3), averaged 4.96±1.44, 31.20±1.98, 8.13±2.22 and 4.87±1.23 days respectively at 20±2 °C. with 60±5% R.H., while it was 1.46±0.35, 22.71±1.27, 6.73±0.82 and 1.99±0.79 days at the same trend at 25±2 °C with 60±5% R.H., while it was 1.04±0.27, 17.41±1.66, 6.20±0.87 and 1.67±0.40 at 30±2°C with 60±5% R.H., when all the individuals were reread on the leaves of (green bean) *P. vulgaris* L.

The female average number of egg was 3.14±2.56, 16.44 ± 3.87 and 22.60 ± 3.63 at 20, 25 and 30±2°C. and 60±5% R.H., when the

individual was reread on the leaves of (green bean) *P. vulgaris* L. respectively. The previous data point out that there were significant differences between the effects of different tested temperature degrees as shown in (Table 2) and Figure 3).

DISCUSSION

The previous results agree with Abd El-Rahman (1996), El-Moghazy (2006) and Sangeetha *et al.* (2013) in laboratory studies on the phytophagous mite, *Eutetranychus orientalis* complex (klein) (Acari: Tetranychidae). The phytophagous mite species passed through one larval and two nymphal stages before being adults.

Childers *et al.* (2009) examined the life history of the phytophagous mite, *Eutetranychus banksi* (McGregor) at various degrees of temperature, females of *Eutetranychus banksi* developed from egg to adult in 29.6, 17.2, 13.1, 11.6, 11.7 and 9.6 days compared to 27.7, 16.4, 12.0, 10.1, 10.8 and 8.5 days for males at 15, 20, 25, 28, 30 and 32 °C. respectively. Developmental times between the both sexes were significantly different ($P < 0.05$) at each temperature. Mites were reared on whole leaf arenas of *Citrus paradisi* Macf.

CONCLUSION

In general, it can be concluded that, the time required for female life cycle, longevity and life span was longer than the male at different tested temperature degrees and the differences were significant and the temperature of 20±2°C gave the longest life cycle, while the temperature of 30±2 °C gave the shortest life cycle.

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Table 1. Effect of temperature on duration of egg incubation period and life cycle of *Eutetranychus orientalis* complex (Klein) (female and male) reared on (green bean) *Phaseolus vulgaris* L. at 20, 25 and 30±2 °C, with 60±5 % R.H.

Stages	sex	Mean duration in days			LSD 0.05%
		20°±2	25°±2	30°±2	
Incubation period	♀	9.34 ± 0.24a	7.99 ± 0.38b	4.80 ± 0.30c	0.286
	♂	9.27 ± 0.50a	7.67 ± 0.40b	4.34 ± 0.33c	0.381
Active larva	♀	4.17 ± 0.43a	3.90 ± 0.36a	1.56 ± 0.27b	0.329
	♂	3.89 ± 0.41a	3.66 ± 0.26a	1.39 ± 0.29b	0.305
Quiescent larva	♀	2.31 ± 0.53a	1.63 ± 0.29b	0.63 ± 0.29c	0.353
	♂	2.10 ± 0.35a	1.33 ± 0.26b	0.47 ± 0.23c	0.264
Total Larval stage	♀	6.50 ± 0.67a	5.53 ± 0.59b	2.19 ± 0.43c	0.527
	♂	5.99 ± 0.61a	4.99 ± 0.37b	1.86 ± 0.32c	0.416
Active Protonymph	♀	2.63 ± 0.42a	2.31 ± 0.34b	1.83 ± 0.26c	0.318
	♂	2.36 ± 0.36a	1.80 ± 0.21b	1.54 ± 0.30b	0.273
Quiescent Protonymph	♀	1.89 ± 0.33a	1.43 ± 0.31b	0.87 ± 0.33c	0.297
	♂	1.49 ± 0.49a	1.24 ± 0.24b	0.65 ± 0.32c	0.333
Total Protonymphal stage	♀	4.56 ± 0.61a	3.74 ± 0.48b	2.70 ± 0.51c	0.490
	♂	3.84 ± 0.68a	3.04 ± 0.36b	2.19 ± 0.44c	0.460
Active Deutonymph	♀	3.39 ± 0.34a	2.30 ± 0.28b	1.04 ± 0.31c	0.284
	♂	2.89 ± 0.41a	1.90 ± 0.28b	0.85 ± 0.32c	0.318
Quiescent Deutonymph	♀	2.50 ± 0.27a	1.69 ± 0.23b	0.75 ± 0.25c	0.231
	♂	1.99 ± 0.50a	1.39 ± 0.25b	0.65 ± 0.20c	0.315
Total Deutonymphal stage	♀	5.89 ± 0.55a	3.99 ± 0.32b	1.79 ± 0.50c	0.427
	♂	4.88 ± 0.72a	3.29 ± 0.50b	1.49 ± 0.50c	0.539
Immature stage	♀	17.07 ± 1.24a	13.26 ± 0.98b	6.68 ± 0.85c	0.949
	♂	14.97 ± 0.75a	11.32 ± 1.00b	5.55 ± 0.99c	0.851
Life cycle	♀	26.37 ± 1.28a	21.25 ± 1.23b	11.48 ± 1.07c	1.098
	♂	24.24 ± 0.92a	18.99 ± 1.28b	9.88 ± 1.16c	1.034
Longevity	♀	19.31 ± 2.48a	10.18 ± 1.44b	8.91 ± 0.84b	1.581
	♂	12.85 ± 1.29a	6.02 ± 0.66b	4.75 ± 0.65c	0.850
Life span	♀	45.68 ± 3.20a	31.43 ± 2.18b	20.39 ± 1.36c	2.173
	♂	37.09 ± 1.49a	25.01 ± 0.90b	14.64 ± 1.22c	1.118

Means in the same coulomb not followed by the same letter are significantly different ($P < 0.05$).

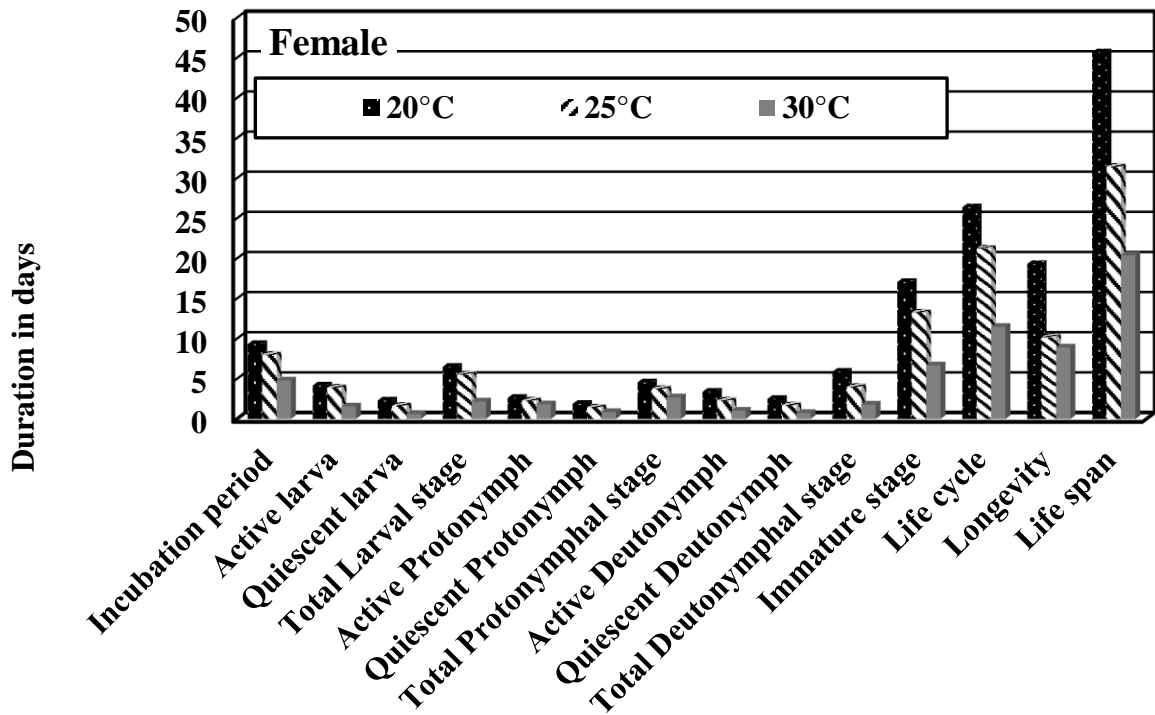


Fig. 1. The effect of different temperature degrees on female development of *Eutetranychus orientalis* complex (Klein) on (green bean) *Phaseolus vulgaris* L.

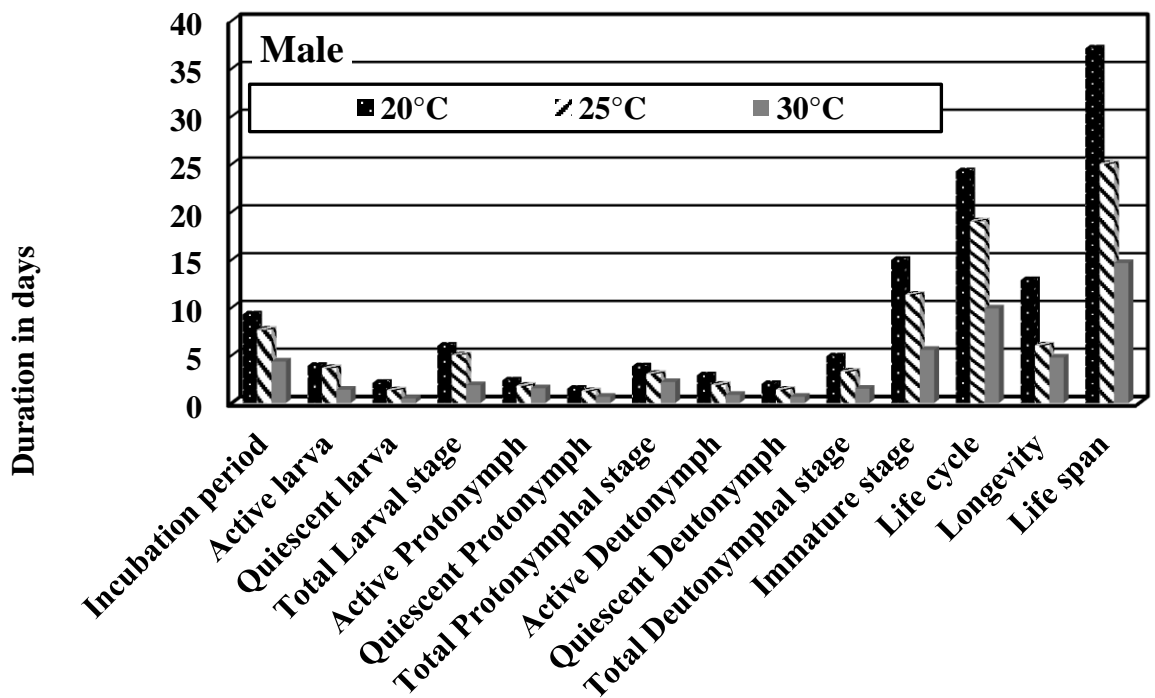
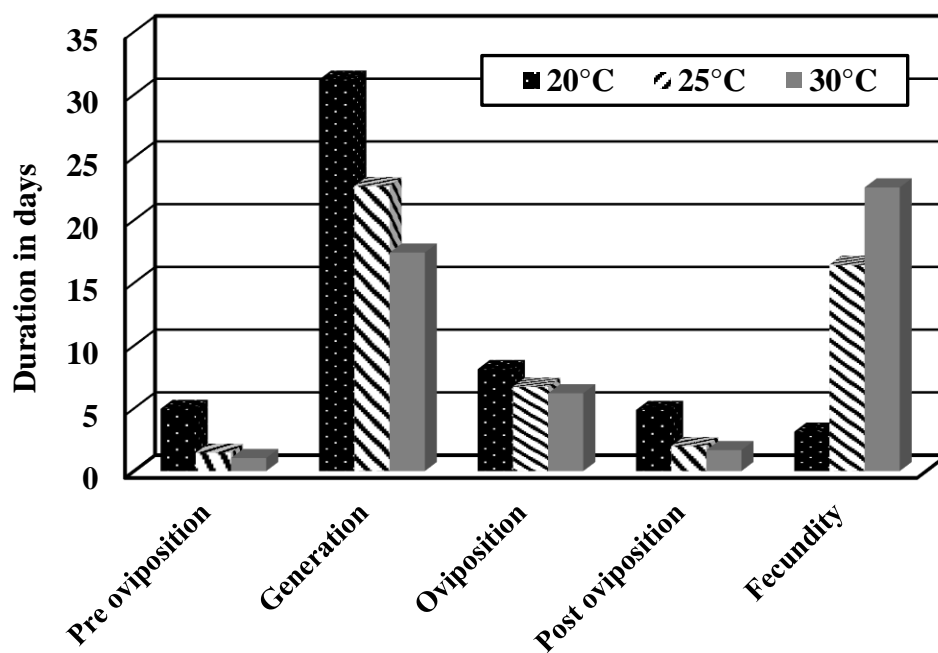


Fig. 2. The effect of different temperature degrees on male development of *Eutetranychus orientalis* complex (Klein) on (green bean) *Phaseolus vulgaris* L.

Table 2. Effect of temperature on longevity, life span and fecundity of *Eutetranychus orientalis* complex (Klein) (female) reared on (green bean) *Phaseolus vulgaris* L. at 20, 25 and 30±2 °C with 60±5 % R.H.

Stages	Mean duration in days			LSD 0.05%
	20°±2	25°±2	30°±2	
Pre oviposition	4.96±1.44a	1.46±0.35b	1.04±0.27b	0.796
Generation	31.20±1.98a	22.71±1.27b	17.41±1.66c	1.524
Oviposition	8.13±2.22a	6.73±0.82b	6.20±0.87b	1.333
Post oviposition	4.87±1.23a	1.99±0.79b	1.67±0.40b	0.804
Fecundity	3.14±2.56c	16.44±3.87b	22.60±3.63a	3.120

Means in the same coulomb not followed by the same letter are significantly different ($P < 0.05$).

**Fig. 3.** The effect of different temperature degrees on specific female stages of *Eutetranychus orientalis* complex (Klein) on (green bean) *Phaseolus vulgaris* L.

تأثير درجات الحرارة على مراحل نمو الحلم العنكبوتي (*Eutetranychus orientalis* complex (klein) (Acari: Tetranychidae) عند التغذية على أوراق (الفاصوليا الخضراء) *Phaseolus vulgaris* L (Acari: Tetranychidae)

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الملخص العربي

الحلم العنكبوتي (Acari: Tetranychidae) يعتبر من أهم الآفات الأكاروسية النباتية على مستوى العالم. تهدف هذه الدراسة إلى دراسة تأثير ثلاث من درجات الحرارة المختلفة على نمو وتطور الحلم النباتي (*Eutetranychus orientalis* complex (klein) (Acari: Tetranychidae) عند التغذية على بعض محاصيل الخضر لتنبؤ بتعداد هذه الآفة تبعاً لدرجات الحرارة السائدة. تم تقدير مراحل نمو وتطور الحلم النباتي (Acari: Tetranychidae) معيلاً على درجات حرارة مختلفة $20\pm 2^{\circ}\text{C}$ ، $25\pm 2^{\circ}\text{C}$ و $30\pm 2^{\circ}\text{C}$ ورطوبة نسبية $5\pm 60\%$ تحت الظروف المعملية، كان الوقت المستغرق للوصول من البيضة وحتى الطور البالغ 1.28 ± 26.37 و 0.92 ± 24.24 يوم على درجة حرارة $20\pm 2^{\circ}\text{C}$ ، 1.23 ± 21.25 و 1.28 ± 18.99 يوم على درجة حرارة $25\pm 2^{\circ}\text{C}$ و 1.07 ± 11.48 و 1.16 ± 9.88 يوم على درجة حرارة $30\pm 2^{\circ}\text{C}$ للإناث والذكور على التوالي. فترة ما قبل وضع البيض، فترة وضع البيض وفترة ما بعد وضع البيض كانت 1.44 ± 4.96 ، 2.22 ± 8.13 و 1.23 ± 4.87 يوم على درجة حرارة $20\pm 2^{\circ}\text{C}$ ، 0.35 ± 1.46 ، 0.82 ± 6.73 و 0.79 ± 1.99 يوم على درجة حرارة $25\pm 2^{\circ}\text{C}$ و 0.27 ± 1.04 ، 0.87 ± 6.20 و 0.40 ± 1.67 يوم على التوالي على درجة حرارة $30\pm 2^{\circ}\text{C}$. كان عدد البيض الموضوع يصل للحد الأقصى عند درجة حرارة $20\pm 2^{\circ}\text{C}$ (3.63 ± 22.60 بيضة/الأنثى) يليها درجة حرارة $25\pm 2^{\circ}\text{C}$ (3.87 ± 16.44 بيضة/الأنثى) ثم درجة حرارة $20\pm 2^{\circ}\text{C}$ (2.56 ± 3.14 بيضة/الأنثى). عموماً يمكن تلخيص النتائج في أن الوقت اللازم لدورة الحياة والبلوغ والعمر الكامل للإناث أطول منه للذكور على جميع درجات الحرارة المختبرة كذلك أن درجة حرارة $20\pm 2^{\circ}\text{C}$ أعطت أطول دروة حياة ودرجة حرارة $20\pm 30^{\circ}\text{C}$ أعطت أقصر دروة حياة.

الكلمات المفتاحية: سوس نباتي، *Eutetranychus orientalis* Complex، Tetranychidae.