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EFFECT OF TEMPERATURE AND LAMBDA-CYHALOTHRIN ON DEVELOPMENT OF IMMATURE STAGES OF THE TWO SPOTTED SPIDER MITE, *Tetranychus urticae* KOH

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ABSTRACT: The present study was directed to evaluate the effect of temperature and Lambda-cyhalothrin residues on development of the immature stages of the two-spotted spider mite, *Tetranychus urticae* Koch. Development of *T. urticae* immature stages was measured at 18, 22, 26 and 30ºC. An increase in the rate of development was noticed at 18ºC. The duration from the egg to each of the successive stages in the life cycle was found to be at least 2.3 times as long as the duration at 30ºC. The duration of development in hours from egg to adult at 26ºC and 30ºC showed no significant differences, and indeed it was virtually identical. By increasing the temperature, the records showed highly significant decrease in the total developmental time, as well as in the durations of different stages in the life cycle. The time required to reach the adult stage increased due to the presence of the sublethal concentrations of Lambda-cyhalothrin. The duration of larval and protonymphal stages (as means) were considerably longer in the mites exposed to Lambda-cyhalothrin. Mortality counts recorded for LC_{50} concentration (65.79 ppm) on adults was also greater in the mites exposed to the tested insecticide.

Key words: Lambda-cyhalothrin,two spotted spider mite,*Tetranychus urticae* Koch,temperatures effect.

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari, Tetranychidae), is a widespread agricultural pest as one of the most serious pests on various crops and vegetables. Mites have always attracted considerable interest because of their small size and especially because of the remarkable habits of some species. The infestation by mites caused a great damage to these infested plants followed by secondary infestation by various pathogens such as virus, bacteria and fungi. The two spotted spider mite (*T. urticae*) is a member of the family Tetranychidae which contains many harmful species of plant feeding mites. It is also a serious pest of ornamental plants and fruit trees in both greenhouse and field crops (Cranham *et al.,* 1985). Life processes are closely related to environmental factors and their temperature plays a crucial role in developmental and reproduction rates of arthropods (Gotoh *et al.,* 2010). Knowing the temperature requirements of the different stages of the life of a target species can be used to forecast its possible distribution and population dynamics. The intrinsic rate of natural increase value (r_m) is a good indicator to describe and evaluate the adaptation and growth of the population of arthropods to distinct environmental situations (Birch, 1948). It has a wide host range including vegetables, ornamentals, herbaceous and woody landscape plants and has been recorded to feed on more than 180 plant species (Johnson and Lyon, 1991).

The life cycle of *T. urticae* is typical of warm weather spider mites. The total life cycle from egg to adult is about 7-8 days at 27.5 - 32.5^{o}C and all the life stages are present throughout the year, depending on the environmental conditions (Sabelis, 1985). Adult longevity and female fecundity of *T. urticae* depend on ecological

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conditions, such as temperatures and host plants (James and Price, 2002). Developmental life cycle slowed when temperature is minimized, requiring up to four weeks for total life span.

Lambda-cyhalothrin is a non-systemic insecticide with contact and stomach action and repellent properties. It gives rapid knockdown and long residual activity. It is used for controlling of a wide spectrum of insect pests, *e.g.* aphids, Colorado beetles, thrips, Lepidoptera larvae, Coleoptera larvae and adults *etc.* In cereals, hops, ornamentals, potatoes, vegetables, cotton and other corps. It provides good control of insect-borne plant viruses at 2.5 g/ha. Also, it is used for control of inset pests in public health. Therefore, objective of the present work was aimed to study the effect of temperature on the developmental rate of *T. urticae* in the presence of Lambada–cyhalothrin residues (Guven and Madanlar, 2000; Kasap, 2002).

MATERIALS AND METHODS

Rearing Technique of *T. urticae*

Red spider mite, *T. urticae* was reared according to the method described by Dittrich (1962) as follows : *T. urticae* individuals were obtained from castor bean plants from Kafr El-Sheikh Governorate and reared under laboratory conditions on caster bean plants which are far away from any contamination with pesticides before starting the experiments. Mites were transferred from old to young plants by cutting heavily infested leaves in small sections which were then placed on new plants. Adult females were collected form stock cultures and allowed to oviposite overnight on castor bean leaves. The females were then removed and the infested leaves with eggs were placed on clean plants. Groups of plants bearing eggs laid within a 24 hours period were transferred to small cages after 16 days of oviposition. An adult female of an uniform age was collected from cultures for experimental use. The culture was kept at 25 ± 2°C and 70 ± 5% RH.

Red spider mite eggs for the experiments were obtained by placing 10 adult females on a clean castor bean leaf disks of 9 cm diameter each as rearing areas placed upon water soaked cotton wool pad in a petri dish. Sufficient disks were set up to provide enough eggs for the experiments and eggs were transferred to experimental arenas as required (Burnett, 1971; Giboney, 1981).

Chemical Used

Lambda-cyhalothrin 5% EC

A reaction product comprising equal quantities of (S) -2- cyano-3 ~ phenoxybenzy1 (z)-(1R3R)3-(2-chloro-3,3,3- trifluoro propeny1) -2,2~dimethyl cyclopropane carboxylate and (R) -a-cyno-phenoxybenzyl (Z)-(1S,3S)-3-(2~ chloro-3,3,3-trifluropropenyl)-2,2-dimethyl cyclopropane-carboxylate. It was supplied by EL-Help Pesticide and Chemicals Company, Egypt.

Techniques for the Assessment of the Tested Compound

To estimate the toxicity of the tested insecticide against the different stages of *T. urticae,* the leaf disks dip technique was used according to Busvine (1971). Serial concentrations from Lambda-cyhalothrin formulation were prepared. Leaf disks of fresh castor bean leaves were dipped in the tested concentrations for 10 seconds. Treated disks were left to dry then offered to the tested stage in petri dishes. Three replicates were made and control experiments involved using leaf disks dipped in water .This trial was carried out in the incubator at 25 ± 2°C and 70 ± 5% RH. Mortality counts for each stage were recorded and LC_{50} concentration 65.79 (ppm) on adult and 10.13 (ppm) on egg stages were calculated. In case of egg stage, toxicity of the tested insecticide was calculated as hatchability percentages.

The Relationship Between Certain Temperatures and the Developmental Rate of *T. urticae*

According to previous work, the range of temperatures used was thought to be the optimum for successful life cycle development of *T. urticae* immature stages which were measured at 18, 22, 26 and 30^{0}C. Experiments were carried out according to the technique of Keratum *et al.* (1994).

At each tested temperature, groups of five young females were removed from the colony

and placed on the leaves. The eggs produced were transferred to the experimental leaves and ten eggs were placed on each leaf. The leaves were replaced every three days. Observations were made daily and the development of immature stages present on each leaf was followed.

RESULTS AND DISCUSSION

Eeffect of Temperature and the Insecticide Lambda-Cyhalothrin Residues on the Development of the Immature Stages of the Two-Spotted Spider Mite, *T. urticae*

The development of *T. urticae* immature stages was measured at 18, 22, 26 and 30ºC to clarify the understanding of the relationship between temperature and the rate of development of *T. urticae*. The effect of Lambda-cyhalothrin residues on *T. urticae* at temperatures of 18 and 26ºC was also investigated and the possible effect of Lambda-cyhalothrin on the development of the immature stages of *T. urticae* was tested.

Effect of temperature

Results given in Table 1 show the time taken for development of all immature stages from egg to adult at the four experimental constant temperatures 18, 22, 26 and 30ºC. Results indicated that the increase in the rate of development at 18ºC, from egg to each of successive stages in the life cycle was found to be at least 2.3 times as long as duration at 30ºC. The records of development from egg to adult at 26 and 30ºC, showed no significant differences and were virtually identical. There were also no significant differences in the periods from egg to protonymph and deutonymph when the temperature was raised from 26 to 30ºC. This is contrary to the results for 18, 22 and 26ºC. For different tested temperatures, results showed highly significant decreases in the total developmental time, as well as in the time for each stage through the life cycle. It is appear, therefore, that between 18 and 26ºC the rate of development is dependent on the temperature of the environment , while above 26ºC, the rate of development is not correlated with temperature and thus no increase in this rate was observed. The duration of the egg stage at 26 and 30ºC was significantly differed. The reduction in egg duration at 30ºC has been compensated by a slight increase in the duration of both larval and protonymphal stages, and no significant difference in the total developmental time was observed at both temperatures.

Table 2 demonstrates the average duration of the immature stages of *T. urticae* for each of the experimental temperatures. The values between brackets indicated the duration of each stage as a percentage from the total time taken for development from egg to adult. The reduction in the developmental time is highly obvious for each of the immature stage with the rate of temperature from 18 to 26ºC. As has already been stated, the rise of temperature from 26 to 30ºC caused a significant reduction in egg duration, but for the other stages there were no significant differences. A slight increase was noticed in the larval and protonymphal durations with a slight decrease in the deutonymphal duration.

Results are nearly in accordance with those obtained by Nickel (1960) on *T. urticae* at 30ºC who reported that the corresponding durations were 41.6 , 18.4 , 17.1 and 23.6 % of the total development. Also, Shih *et al.* (1976) studied the development of *T. urticae* at 27ºC and found that the egg duration occupied 44% of the total life cycle, which is distinctly close to the present results. However, the results in Table 1 suggest that changes in the developmental rates at different temperatures are induced by a certain effect during the embryonic growth.

Table 3 indicates that the percentage of duration time for each immature stage at 22, 26 and 30ºC has been reduced compared with the values obtained at 18ºC. It appears that the reduction in the developmental time occurred between 18 and 26ºC, which indicates that the rate of development for all the immature stages of *T. urticae* is dependent on temperature . At temperatures above 26ºC a plateau was reached and the increase in temperature do not result in a reduction in developmental time. It may appear that there is a rate controlled process would be involved in *T. urticae* development which reaches a maximum at point between 22 and 26ºC. It is unlikely that cell division was affected.

Table 1. Duration (in hours) of *T. urticae* developmental stages at different temperatures at ± 95% confidence limits

Stage	Temperature (ºC)				Significance
	30ºC	26ºC	22ºC	18ºC	
Egg to larva (incubation period)	88.3±4.3	95.9±3.7	156.1±6.6	219.0±7.03	18»22»26>30
Egg to protonymph	130.7±4.9	133.6±4.0	220.7±8.4	309.8±7.8	18»22»26-30
Egg to deutonymph	166.0±5.7	164.3±4.7	275.6±8.3	381.4±8.2	18»22»26-30
Egg to adult	205.6±5.7	206.1±5.5	329.6±12.8	477.0±7.7	18»22»26-30

± (SE) = Standard error.

Table 2. Duration (in hours) of egg, larva, protonymph and deutonymph stages of *T. urticae* at different temperatures

Stage	Temperature (ºC)			
	30 ºC	26 ºC	22 ºC	18 ºC
Egg (incubation period)	88.3	95.9	156.1	219.0
	(42.9)	(46.5)	(47.4)	(45.9) *
Larva	42.4	37.7	64.6	90.8
	(20.6)	(18.3)	(19.6)	(19.0)
Protonymph	35.3	30.7	54.9	71.6
	(17.2)	(14.9)	(16.7)	(15.0)
Deutonymph	39.6	41.8	54.0	95.6
	(19.3)	(20.3)	(16.4)	(20.0)

* (%) from total time = Figures between brackets.

Table 3. Reduction percentage in the duration (in hours) of different stages of *T. urticae* at 30, 26 and 22ºC relative to that at 18ºC (as standard)

Stage	Temperature (ºC)			
	30ºC	26ºC	22ºC	18ºC
Egg	59.7	56.2	28.7	11.6
Larva	51.7	57.1	26.4	14.2
Protonymph	52.7	58.8	26.4	14.5
Deutonymph	58.6	56.3	43.5	13.8

Bourdeaux (1963) suggested that all somatic cells are formed in the larval instars , and any increase in size of mites is a result of cell size increase. If cell division was the factor involved, one could expect the stages in which cell division was the greatest (*i.e.,* the egg and larva) to be affected to a greater degree than the other stages. The process is also unlikely to be feeding because although there was a significant decrease in duration of the non-feeding stage (egg), the degree of feeding in the active immature stages varied considerably (Shih *et al*., 1976), and one would not expect exactly comparable effects to be exerted on different levels of feeding.

The results also suggest that the effect of temperature on development is to exert an equivalent amount of change on each stage remains unaltered. The proportion of the total time spent in each stage is of importance when considering biological control complexes. As was noted by Nickel (1960) the length of time spent in various stages may have an important bearing on exposure to predation. Shih *et al.* (1976) reported that the longer the time spent in the egg stage, the longer the period for predation by egg feeding phytoseiid predators in a predator prey interaction. However, if the proportion of time spent in each stage is not altered, then the relative susceptibility of *T. urticae* to be attacked by predacious mite will not be altered at different temperatures, regardless of predator preferences.

Nizam *et al.* (2017) studied the life table of the indigenous *Neoseiulus californicus* at different temperatures from 15 to 35°C and 65 ± 5% relative humidity under conditions of 16 hr. light : 8 hr. dark (LD 16:8). The total developmental period from egg to adult varied from 14.0 to 3.0 days at 15 to 35°C. Survival to adulthood ranges from 86.21 to 93.94%, with the highest rate at 25°C. The lower threshold temperature from egg to adult stage of females and males was 10.84 and 10.72°C, respectively, and the thermal constant was 57.14 degree-days (DD) for females and 56.18 DD for males. Total number of eggs laid by each female was the highest (70.38 eggs) at 25°C, whereas average daily fecundity was the highest (3.69 eggs/ female/day) at 30°C. The net reproductive rate was the highest (48.49) at 25°C and was the lowest (26.18) at 30°C. Mean generation time decreased from 19.04 to 11.47 days with increasing temperature from 20 to 30°C. Both intrinsic rate of natural increase (0.284) and finite rate of increase (1.32) were maximum at 30°C. Adult longevity was the highest (42.75 days for females and 32.60 days for males) at 20°C and the lowest (22.70 days for females and 15.30 days for males) at 30°C. Sex ratio was female biased and was the highest (78.08) at 25°C and the lowest (70.24) at 30°C. Developmental data of five constant temperatures, temperature thresholds and thermal requirements may be used to predict the occurrence, number of generations and population dynamics of *N. californicus* as an important biocontrol agent of *T. urticae*.

Treatment with Lambda-cyhalothrin

This treatment was carried out at 18 and 26ºC, and the results are given in Table 4. At 18ºC, results indicated that the length of the total developmental time of the life cycle was increased in the presence of the tested insecticide. The means for larval and protonymphal durations were considerably longer in mites exposed to the insecticide Lambda- cyhalothrin. There was a very high level of mortality (57.4%) encountered in this experiment (Table 5). This level was higher than that occurred on untreated leaves at 18ºC, and greater than the level reported by Shih *et al.* (1976) on untreated leaves at 27ºC. Thus, it seems that the application of the chemical contributed considerably to the mortality, and showed the development of the surviving mites.

At 26ºC, the insecticide residues prolonged the developmental time required to reach the adult stage. This treatment induced in a lower level of mortality than that at 18ºC, but the mortality, in general, was greater for the mites exposed to the insecticide tested Lambda-cyhalothrin. The insecticide caused higher mortality and retarded development, the latter may be due to a side toxic effect.

The presence of chemicals on the leaf surface may act as an irritant or repellent, or make the plant substrate less acceptable, so that it becomes less suitable for mite development, which may alter the time taken for immature stages to complete their development (Aziz, 1985).

Table 4. Effect of Lambda-cyhalothrin on the duration (in hours) of survival individuals of *T. urticae* at different stages at two different temperatures

Temperature	Treatment (LC_{50})	Egg to larva	Larva to protonymph	Protonymph to deutonymph	Deutonymph to adult
18ºC	Control	219.0±7.03	90.8±0.77	71.6±0.4	95.6±0.5
	Lambda-cyhalothrin (65.79 ppm) to adult and larva (10.13 ppm) to egg	249.6±8.2	128.2±4.5	118.0±4.0	135±4.8
26ºC	Control	95.9±3.7	37.3±0.3	30.7±0.7	41.8±0.8
	Lambda-cyhalothrin (65.79 ppm) to adult and larva (10.13 ppm) to egg	113.9±3.9	55.3±2.8	58.5±2.9	67.9±3.1

Table (5). Mortality percentage of different stages of *T. urticae* during development under different treatments of temperature and Lambda-cyhalothrin

Treatment		Egg to larva	Egg to protonymph	Egg to deutonymph	Egg to adult
Temperature	**Chemical (LC_{50})**				
18 ºC	-	31.2	33.0	36.3	36.3
22 ºC	-	24.8	29.7	29.7	32.2
26 ºC	-	14.9	14.9	19.8	19.8
30 ºC	-	19.8	25.3	27.4	27.4
18 ºC	Lambda-cyhalothrin (65.79 ppm) to adult and larva (10.13 ppm) to egg	49.5	51.3	52.3	57.4
26 ºC	Lambda-cyhalothrin (65.79 ppm) to adult and larva (10.13 ppm) to egg	36.5	36.3	36.3	41.3

Hosny *et al*. (2009) indicated that cyhalothrin is the most effective compound tested on egg deposition of spider mite which give these compounds special importance in integrated mite management. Ismail (2007) stated that cypermethrin was highly toxic compound that caused the highest decrease in egg hatchability on leaf discs against egg stage of *T. urticae* but etoxazole and wormwood extract were the least effective as ovicidal. Hosny *et al*. (2010) indicated that cyhalothrin was highly toxic compound that caused the drastic drop in egg hatchability, while ethion and abamectin were about of the same ovicidal effect against the egg stage of spider mite. black cumin extract exhibited the least effective ovicidal action of spider mite *T. urticae*.

REFERENCES

Aziz, F.A. (1985). The effect of the host plant on the predition of red spider mite by *Amblyseius fallacies*. Ph.D. Thesis, Bangor .

Birch, L.C. (1948). The intrinsic rate of natural increase of an insect population. J. Anim. Ecol., 17: 15–26.

Bourdeaux, H.B. (1963). Biological aspects of some phytophagous mites. Ann. Rev. Ent., 8: 137-154.

Burnett, T. (1971). Prey consumption in Acarina predator- prey populations read in the green-house. Can. J. Zool, 49: 903-913.

Busvine, J.R. (1971). Acaricidal review of the techniques for testing insecticides. Common Wealth Inst. Entomol., 345.

Cranham, J.E., W. Helle and M.W. Sabelis (1985). Editors. Spider mites, their biology, natural enemies and control. 1B.PP., 367-370.

Dittrich, V. (1962). A comparative study of toxicological test methods on a population of the two-spotted spider mite *Tetranychu surticae*. J. Econ. Entomol., 55 (5): 644- 648.

Giboney, F. (1981). A laboratory evaluation on *Amblyseius fallacis* (Garman) (Acarina: Phytoseiidae) as a control agent for tetranychid mites. Ph.D. Thesis, UCNW. Bangor.

Gotoh, T., N. Sugimoto and A. Pallini (2010). Reproductive performance of seven strains of the tomato red spider mite *Tetranychus evansi* (Acari: Tetranychidae) at five temperatures. Exp. Appl. Acarol., 52: 239–259.

Guven, B. and N. Madanlar (2000). Investigations on the population density of *Tetranychus urticae* Koch on corn grown as a second crop in Salehi (Manisa) and its biology on two different corn varieties in laboratory. J. Entomol., 24: 279-288.

Hosny, A.H., A.A. Ismail and A.Y. Keratum (2009). Integrated mite management determination of sublethal doses of some compounds against the two spotted spider mite, *Tetranychus urticae* and their effects on its biological aspects with to predators *Amblysieus fallacis* and *Phytoseiulus persimilis*. J. Agric. Res., Kafr El-Sheikh Univ., 35 (4): 1096-1113.

Hosny, A.H., A.Y. Keratum and N.E. Hassan (2010). Comparative efficiency of pesticides and some predators to control spider mites. J. Plant Prot. and Path., Mansoura Univ., (12): 1065-1085.

Ismail, A.A. (2007). Laboratory evaluation of some environmentally safe chemicals against the two spotted spider mite, *Tetranychus urticae* and its predatory insect, *Stethorus gilvifrons*. J. Pest Cont. Environ. Sci., 15 (1): 113-141.

James, D.G. and T.S. Price (2002). Fecundity in the two-spotted spider mite (Acarina: Tetranychidae) is increased by direct and systemic exposure to imidacloprid. J. Econ. Entomol., 95: 729-732.

Johnson, W.T. and H.H. Lyon (1991). Insects that Feed on Trees and Shrubs. Comstock Publishing and Cornell University Press, Ithaca, NY.

Kasap, I. (2002). Biology and life tables of the two-spotted spider mite, *Tetranychus urticae* Koch (Acarina: Tetranychidae) on three different host plants in laboratory conditions. Turk. J. Entomol., 26: 257-266.

Keratum, A.Y., H. Anber, M.M. Essawy and F.I. El-Shahawi (1994). The effect of Permethrin residues on the activity of the predators *Phytoseiulus persimilis* and *Amblyseius fallacis*. Alex. Sci. Exch., 15 (1): 67- 82.

Nickel, J.L. (1960). Temperature and humidity relationship of *Tetranychus urticae* with special reference to distribution. Hilgardia., 30 (2): 41-100.

Nizam, U., Z. Alam and R. Uddin (2017). Life table parameters of an indigenous strain of *Neoseiulus californicus* McGregor (Acari: Phytoseiidae) when fed *Tetranychus urticae* Koch (Acari: Tetranychidae). Entomol. Res., 47 (2): 84–93

Sabelis, M.W. (1985) Sex allocation. In: Spider Mites, Their Biology, Natural Enemies and Control (Ed., M.W. Sabelis), Elsevier, Amsterdam, 1B: 83-94.

Shih, C.T., S.L. Poe and H.L. Cromroy (1976). Biology, life table and intrinsic rate of increase of *Tetranychus urticae*. Ann. Ent. Soc. Am., 69: 362-364.

تأثير درجة الحرارة ولمبادا-سيهالوثرين على نمو الأطوار غير البالغة للحُلُم العنكبوتي ذو البقعتين تترانيكس أورتيكا

حمدي عبد الرحيم عبد الرحمن - هند سعد الطحاوي

مركز البحوث الزراعية- معهد بحوث وقاية النباتات - الجيزة - مصر

تم تقدير فترات نمو الأطوار غير البالغة للحلم العنكبوتى تترانيكس أورتيكا فى المعمل عند درجات حرارة ١٨، ٢٢، ٢٦و٣٠°م، وقد لوحظ تزايد في فترة النمو عند درجة حرارة ١٨°م من طور البيضة حتى الأطوار التالية من دورة الحياة بما يصل إلى ٢,٣ مرة قدر هذا القياس عند درجة حرارة ٣٠°م، ولم تُظهر فترات النمو (ساعات) إبتداء من طور البيضة حتى الطور البالغ عند درجتي حرارة ٢٦و٣٠°م أي فروق معنوية، وبصفة عامة فإن تلك الفترات عند درجات الحرارة المختلفة أظهرت انخفاضا معنوياً جداً في الفترة الكلية للنمو بارتفاع درجة الحرارة من ١٨ إلى ٣٠°م وأيضاً الفترة بين طور البيضة وكل من الأطوار التالية في دورة الحياة، ولقد سبب وجود مبيد لمبادا-سيهالوثرين زيادة الوقت اللازم للوصول من طور البيضة إلى الطور البالغ وكانت فترة نمو طوري اليرقة والحورية الأولي في الأفراد المعرضة لتركيزات غير قاتلة من المبيد أكبر من مثيلتها في الأفراد غير المعرضة له وكذلك زادت نسبة الموت للأفراد الكاملة عند المعاملة بالتركيز النصفى القاتل (٦٥,٧٩ جزء فى المليون) للمبيد محل الدراسة.

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