EFFECT OF HIGH TEMPERATURE SHOCK ON SURVIVAL OF THE GRAIN MITE *TYROPHAGUS PUTRESCENTIAE* (SHRANK) (ACARI : ACARIDIDA)

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(Manuscript received 3 March 2009)

Abstract

Heating is used extensively to control some pests as well as stored-product pests. There are three temperature zones for any organisms: optimal at 25-33°C for is greatest rate of growth and reproduction, suboptimal at 33-35°C, mites able to complete their development slowly and produce offspring and Lethal >35°C eventually die, The more extreme of temperature the more quickly die with death occurring in few minutes at 45°C or hours at 50-60°C.

Lethal effect of high temperature (40, 45 & 50 °C) for different exposure periods (5, 15, 30, 60, 90 &120 min.) , respectively, on survival stages of *Tyrophagus putrescentiae* (Shrank) was studied. Heat shock treatment reduced the number of all stages. The mean of mortality percentage increased with increasing temperature and duration. These percentage were 83, 87 & 92 % for egg, 81.8, 86.2 & 91.7 % for larva, 71.3, 82.2 & 88.7% for protonymph and 70.3, 81.5 & 86% for deuotonymph at 40, 45 & 50°C, respectively. it is notice thus mortality increased by increasing temperature and long time. Therefore all stages of the grain mite *T. putrescentiae* die at 50°C and 60 min exposure. At 45°C high mortality percentages occurred between mite individuals at 90 min. while treatments at 40°C and 120 min. exposure gave similar mortality percentage.

INTRODUCTION

The Acari includes a large economic group of arthropods (especially those of Acaridida) which are found commonly in stored products, where they cause injury by feeding and creating, in many instances, difficult contamination problems. For many years chemical measures have dominated the methods for pest control in grain, but recently more interest has been directed towards non-chemical methods. Such methods are needed because all major species of stored product pests have developed varying degrees of resistance to the limited number of pesticides which are internationally accepted for use on grain (Champ and Dyte, 1976). At the same time, new chemicals that are safe enough for use on foodstuffs are only slowly becoming available, because of high cost of developing and registering as "residue free" The experiment that has been successful for many years against stored product pests is the use of elevated temperatures. Heat shock is the form of stress caused by rapid exposure to high temperatures. Chen *et al.,* 1991),and Waddell *et al.,* (1993) determined the thermal death point for adult female *Tetranychus urticae* after heat temperature in water vapor air. (However, studies, on the impact of short exposure periods of high temperatures on the biology of *T. urticae* have not previously been carried out). The thermal limits of insects and mites usually fall between 0 and 50°C and temperatures within these limits determine the rates of population growth. More extreme temperatures have an acute influence. At upper limit, the high temperatures destabilize phospholipids membranes and affect intracellular proteins adversely (Bligh *et al.*,1976). Heat disinfestations requires only that all particles of a given batch of infested grain are heated to an appropriate lethal temperature/combination and this is basically a simple process. It can be adapted to both "low tech and high tech" circumstances (Kitch *et al.*, 1992). Different mite and insect species and stages have different susceptibilities to heat treatment, but most species will not survive more than 12h at 45°C, 5 min. at 50°C and 30s. at 60°C (Fields, 1992). Mortality is obviously related to the temperature to which the pests are exposed and the exposure period. A heating block system was developed at Washington State University (WSU), Pullman, WA that provides accurate heating rates and temperature control in treating different insects. This system was used to study the thermal death kinetics of fifth instars codling moth (Ikediala *et al.,* 2000, Wang *et al.,* 2004), thermal of different life stages insect (Johnson *et al.* , 2003), and fifth instars navel orange worm. The same system was also used to determine the most heat resistant life stage of navel orange worms for developing thermal treatment protocols against field pests in shell walnuts (Wang *et al.,* 2002c).

The present work aims to study the effect of high temperature stress (40, 45 & 50°C) with different exposure times (5, 15, 30, 60, 90 & 120 min.) on survival stages of *Tyrophagus puterscntiae* (Sharank)

MATERIALS AND METHODS

Pure culture

A pure culture of the grain mite *T. puterscntiae* (Sharank) belonging to the family : Acaridae, was prepared by confining adult females and males in a rearing plastic chamber (5.5 cm diameter x 1.5 cm high) filled up to 0.5 cm. with plaster of Paris and activated charcoal (8:1) . One adult female and male of the mite were placed in a plastic cell, supplied with dray yeast and a few drops of water added daily as a source of relative humidity. The cultures were observed daily and kept in an incubator at 25 °C ± 2 and 60 **±** 5 % R.H.

Eggs

Assessment of reduction measured after exposing eggs to three high temperatures 40, 45 and 50°C for various short exposure period. They were then reared on 25°C as the control temperature. Ten replicates were taken for each temperature and the surviving eggs were examined daily unit all eggs were dead.

Immature stages

Ten molted active immature stages (larva, protonymph and deutonymph) were placed in the rearing plastic chamber and distributed among three incubators of 40, 45 and 50°C for various exposure periods 5, 15, 30, 60, 90 and 120 min, respectively. Ten replicates for each treatment were used. The surviving mites were kept at 25°C and examined daily. Assessment mortality of larva, protonymph and deutonymph and also the percentage of survival were measured.

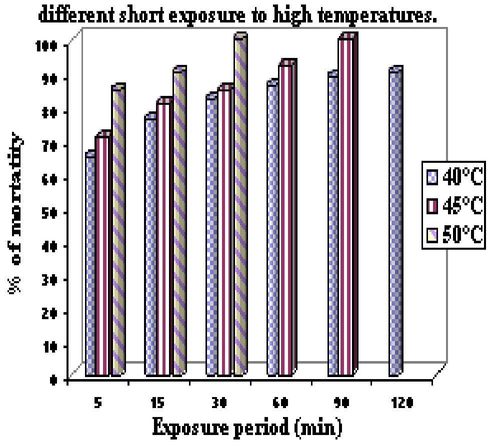
RESULTS AND DISCUSSION

Data in Table (1) indicated that the mean percentage mortality for *T. puterscntiae* eggs after shock exposure (5, 15, 30, 60, 90 & 120 min.) at high temperatures (40, 45, 50°C) significantly increased with increasing the degree of temperature. The mean percentage of egg mortality was represented by 92% at highest degree 50°C also recorded 100 with short exposure 30 min, the mean significantly and gradually decreased at 45°C and recorded reduction 100% at 90 min, while at 40°C 83%, recording 100 at 120 min The interaction effect of high temperatures with short exposure period was highly significant.

Table 1. Percentage of mortality for *Tyrophagus putrescentiae* eggs after different shock exposure at high temperatures.

Exposure period min.	High degree of temperatures		
	40°C	45°C	50°C
5	65	71	85
15	76	81	90
30	82	85	100
60	86	92	0
90	89	100	0
120	100	0	0
Mean	83%	87%	92%

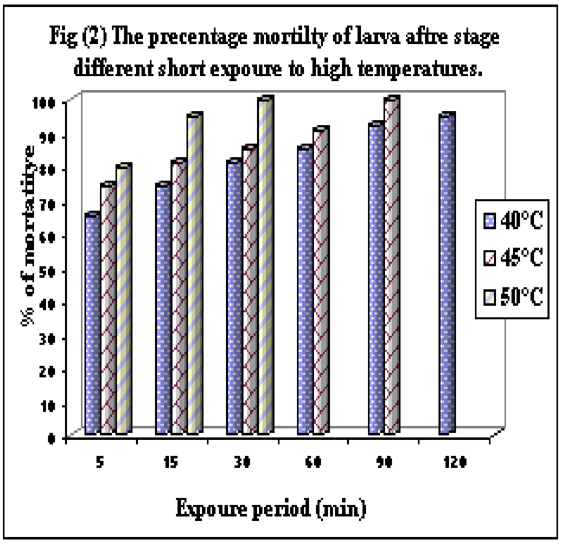
Fig (1) The precentage mortilty of eggs aftre different short exposure to high temperatures.



The obtained results in table (2) cleared that the high temperature was more effective in reducing the mite larval stage. The mean percentage mites mortality treated by high temperature at the three tested degree with six exposure periods were significantly the mortality. However, the mean mortality percentages, then gradually and insignificantly increased to (81.8, 86.2 & 91.7 %) for increased of degree to (40, 45 & 50°C) for above mentioned exposure periods, respectively. It also recorded 100% with short exposure 30 min, then for degree 45°C recorded reduction 100 at 90 min, while degree 40°C recorded 95% at 120 min The interaction effect of highly temperatures with short exposure period was high significant.

Table 2. Percentage of mortality stage Tyrophagus putrescentiae larvae after different shock exposure at high temperatures.

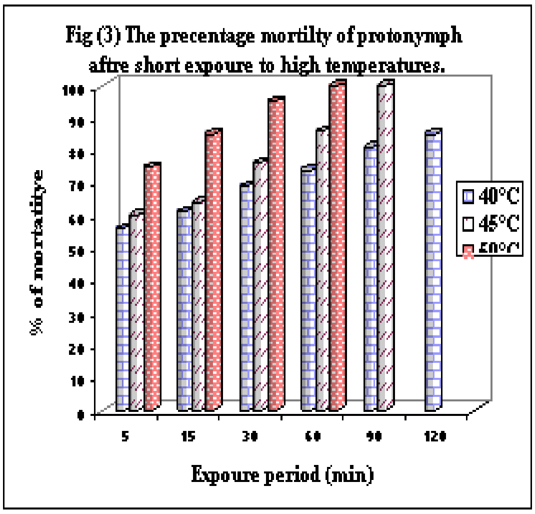
Exposure period min.	High degree of temperatures		
	40°C	45°C	50°C
5	64	74	80
15	74	81	95
30	81	85	100
60	85	91	0
90	92	100	0
120	95	0	0
Mean	81.80%	862%	91.70%



The effect of the high temperature and intervals exposure on mean potopnymph mortality percentage are presented in Table (3). The obtained results showed that the highest mean percentages 88.7, 82.2 &71.3 % followed discerningly and represented high significant by of temperatures 50 ,45 & 40 °C**.** Also it recorded 100 with short exposure 60 min. 45°C recorded100% reduction at 90% min, while degree 40°C recorded 90 at 120 min The interaction effect of high temperatures with short exposure periods was highly significant.

Table 3. Percentage of mortality for stage *Tyrophagus putrescentiae* protonymph after different shock exposure at high temperatures.

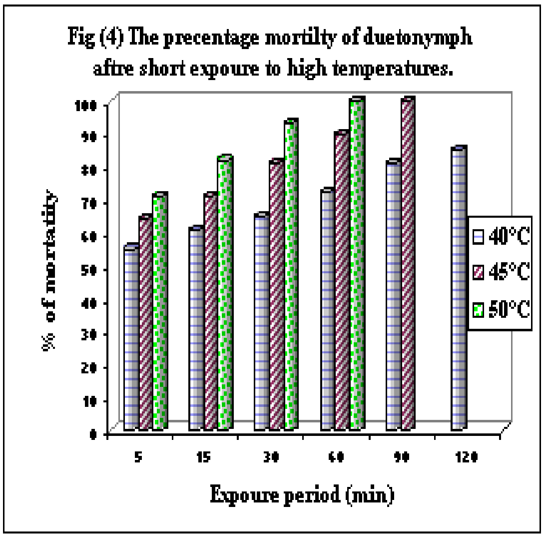
Exposure period min.	High degree of temperatures		
	40°C	45°C	50°C
5	56	69	75
15	61	71	85
30	69	80	95
60	71	91	100
90	81	100	0
120	90	0	0
Mean	71.30%	82.20%	88.70%



Data in Table (4) indicated that the mean dueotonymph mortality percentage after shock exposure (5, 15, 30, 60, 90 & 120 min.) at high temperatures (40, 45, 50°C) significantly increased with increasing the degree of temperature. Mean percentage dueotonymph of mortality percentage egg was represented by 86.5% at the highest degree 50°C. It also recorded 100 with short exposure 60 min, then significantly and gradually decreased for degree 45°C lasted 80.5% and recorded reduction 100 at 60 min. while degree 40°C gave 70.3%, and 85% at 120 min. The interaction effect of high temperatures with short exposure period was highly significant.

Table 4. Percentage mortality of stage T. putrescentiae deuotonymph after different shock exposure at high temperatures.

Exposure period min.	High degree of temperatures		
	40°C	45°C	50°C
5	55	65	71
15	61	71	82
30	65	86	93
60	75	100	100
90	81	0	0
120	85	0	0
Mean	70.30%	80.50%	86.50%



Due to adverse nature of some established methods there is a constant search for new means of controlling mites in stored grains. Our heat studies showed that mortality percentage increased with increasing exposure and temperature degrease for all stages (egg, larva, protonymph and deutonymph, 40, 45 & 50°C). This conclusion agree with the conclusion returning to spider mite as Crooker (1985) reported that the upper lethal limit for immatures may be 38-40°C, but much variation can be expected depending on species, life stage, humidity and duration of exposure. therefore, Tanigoshi *et al.* (1975) observed high mortality rates in active immature stages of *Tetranchus macdanieli* at 38°C.The rate of all immature stage reaching adult stage decreased with increasing period and with increasing temperature treatment. This rate reached to 0% for all immature stages at 50°C for 120 min. This conclusion agree with the conclusion of Okasha (1986c) that growth and development are not initiated at high temperature, but on the contrary, these processes start after transfer to normal temperature. He found that after transfer of the nymphs to normal temperature (28°C), molting is delayed. The duration of the delay is directly proportional to the period exposure to high temperature. He explained that the brain hormone is not secreted during the period of exposure to high temperatures, so that molting ceases at high temperatures.

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تاثير درجات الحرارة العالية على حياة اكاروس الحبوب المخزونة ***Tyrophagus putrescentiea*** من عائلة (**Acaridae**) التابعة لتحت رتبة عديمة الثغر

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استخدمت الحرارة العالية فى مكافحة بعض الافات وخاصة آفات الحبوب والمواد المخزونة ، يوجد ثلاث مناطق حرارية لاى كائن حى : المنطقة الحرارية الاولى هى درجة الحرارة ٢٥–٣٣ م° تعتبر درجة حرارة مثلى للنمو والتطور وخصوبة الاناث ونسبة الفقس للبيض والمنطقة الحرارية الثانية تحت المثلى هى ٣٣ – ٣٥ م° تستطيع الافراد ان تكمل نموها وتعطى بيض والمنطقة الحرارية الثالثة المميتة تكون اكثر من ٣٥ م° يكون فيها التطور بطئ ولا يكتمل ولكن بارتفاع الحرارة عن هذا المستوى الى ٤٠ م° تموت الافراد فى ايام واذا ز ات الى ٤٥ م° تموت فى ساعات واذا زات الى ٥٠ – ٦٠ م°تموت الافراد فى دقائق لذا فان الدراسة استهدفت الى استخدام درجات الحرارة العالية للحد من اعداد الافة بتعريض هذة الاطوار المختلفة للحلم الحبوب *T.putrescntiae* عند درجة حرارة ٤٠ ، ٤٥ ، ٥٠م° لفترات مختلفة (٥، ١٥، ٣٠، ٦٠، ٩٠ & ١٢٠دقيقة) على الترتيب.

اوضحت النتائج ان معدل نسبة الموت للبيض عند درجة الحرارة ٥٠ م° كانت ٩٢% بمعدل موت ١٠٠ عند فترة تعريض ٣٠ دقيقة بينما كانت ٨٧% عند درجة الحرارة ٤٥ م° بمعدل موت ١٠٠ عند فترة تعريض ٩٠ دقيقة بينما كانت ٨٣% عند درجة الحرارة ٤٠ م° بمعدل موت ٩٥ عند فترة تعريض١٢٠ دقيقة على الترتيب. حيث اظهرت النتائج ان معدل نسبة الموت للطور اليرقى عند درجة الحرارة ٥٠ م° كانت ٩١.٧% بمعدل موت ١٠٠ عند فترة تعريض ٣٠ دقيقة بينما كانت ٨٦.٢% عند درجة الحرارة ٤٥ م° بمعدل موت ١٠٠ عند فترة تعريض ٩٠ دقيقة بينما كانت ٨١.٨% عند درجة الحرارة ٤٠ م° بمعدل موت ٩٥ عند فترة تعريض١٢٠ دقيقة على الترتيب. اوضحت النتائج ان معدل نسبة الموت للطور الثالث عند درجة الحرارة ٥٠ م° كانت ٨٨.٧% بمعدل موت ١٠٠ عند فترة تعريض ٦٠ دقيقة بينما كانت٨٢.٢% عند درجة الحرارة ٤٥ م° بمعدل موت ١٠٠ عند فترة تعريض ٩٠ دقيقة بينما كانت ٧١.٥% عند درجة الحرارة ٤٠ م° بمعدل موت ٩٥ عند فترة تعريض١٢٠ دقيقة على الترتيب. اوضحت النتائج ان معدل نسبة الموت للطور الرابع عند درجة الحرارة ٥٠ م° كانت ٨٦.٥% بمعدل موت ١٠٠ عند فترة تعريض ٦٠ دقيقة بينما كانت ٨٠.٥% عند درجة الحرارة ٤٥ م° بمعدل موت ١٠٠ عند فترة تعريض ٩٠ دقيقة بينما كانت ٧٠.٣% عند درجة الحرارة ٤٠ م° بمعدل موت ٨٥ عند فترة تعريض ١٢٠ دقيقة على الترتيب. فان ارتفاع درجة الحرارة العالية مع التعريض الى فترات مناسبة تعتبر احدى عوامل المكافحة الطبيعية للاكاروسات المواد والحبوب المخزونة.