

EFFECTS OF ULTRASONIC EMITTING DEVICES AS A KIND OF STRESS ON BIOLOGICAL AND PHYSIOLOGICAL CHANGES ON THE CONFUSED FLOUR BEETLE, *Tribolium confusum* (DUVAL) (COLEOPTERA TENEBRIONIDAE).

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ABSTRACT

Adult of the confused flour beetle, *Tribolium confusum* (du Val) reared on wheat flour were exposed to emissions from ultrasonic unit and other stresses (24hrs.light, 24hrs.dark and 24hrs. 45C°). Ultrasonic caused mortality in adult and larvae. Significant differences recorded in mortality between the treated and untreated (control) beetles during the 4 months of exposure. Also, significant differences were obtained in length of larval duration, pupation time and body weight in adult between the treated and the control Groups. The results also indicated that cholinesterase activity decreased with the active ultrasonic-emitting devices.

INTRODUCTION

Many insects including confused beetle, *Tribolium confusum* have developed resistance to insecticides, and the number continues to increase, as noted by Brown, 1969. Therefore, it seems imperative that other means of control exploited. A better understanding of the behavior of insects and the utilization of their behavioral characteristics to their detriment is a promising approach to non chemical control. The use of ultrasonic sound (ultrasound) to eliminate or manage pests in the near environment has been widely publicized over the past 3 years. As interest and Confusion in the use of ultrasonic persist, public and private organization have come Provide recommendation regarding this technology (Dunn1982, Rambo 1982, Miller 1983).

Ultrasonic pest repelling devices have repeatedly been shown to be completely useless (Nancy and Koehler, 1990). Many pests hear sound for above the hearing range of humans. Sound waves that help repel targeted pests from the protected area. Humans are capable of hearing sound generally in the frequency range of 10 Hertz (Hz) to 1500Hz; many small insects communicate at these very high (Ultrasonic) frequencies. Laboratory research has shown ultrasonic sound waves attack the auditory and nervous systems of most common pests causing them pain and discomfort. The auditory structures of the beetle are typical of other insect ears in that they have a thinned tympanic membrane backed by a tracheal airsac with associated Chordotonal sensory Structures or tympanic membranes that sense Ultrasonic vibration (Forrest *et al.*,1997).Confused flour beetle *Tribolium confusum* is a cosmopolitan and experimental stored product insect and a major cause of loss in stored grain products. They contaminate via their excreta and by their exoskeletons and dead bodies (Cotton and Wilbur, 1974). During feeding and reproduction the metabolic activity of insects can

1974). During feeding and reproduction the metabolic activity of insects can increase the moisture level and temperature of product making it suitable for fungal growth (Dunkel, 1988).

Since ultrasonic used on many insects, the idea to know effects of emitted device of ultrasonic as a control method on confused flour beetle as major insect stored products is found important.

The present investigation dealt with biological and physiological changes according to ultrasonic effects.

MATERIALS AND METHODS

Rearing insects.

Tribolium confusum cultures were reared on whole- wheat flour at $25 \pm 5^\circ$ and 65% r h .Adults separating to sexes in pupal stage to identify males and females by end of the pupa, the female papillae, which are much larger than those of the male, are two finger –like structures just anterior to the pointed urogomphi. The male papillae are enough smaller that they look just fingertips rather than finger. Larvae (3rd instars), collected periodically from cultures (Halstead, 1963).and then placing the sexes on flour in separate containers to complete their development.

Adult and young larvae were separated from the diet using a 0.83-mm aperture sieve and 250-um- aperture sieve, respectively (Rizana et al., 2003).

Application of Ultrasonic and other stresses.

1-TheUltrasonic automatically sweeps Range of 24000Hz to 45000 Hz from small unit so that the waves were directed into it from a distance of about 20 cm.

2- Physical stresses were applied by 24hrs. artificial light and 24hrs. dark under $25 \pm 5^\circ$ for experimental period.

3- Heat stress were applied by raising temperature to 45° 24hrs. for experimental period.

The beetles were exposed to ultrasonic emitted devices combined with the other stresses (light- dark-heat by raising temperature to 45°).

1 -Primary experiments of escaping insects:-

Five Petri dishes each one contained twenty gm wheat flour and 30 adults replicated three times.

2-Biological experiments

According to Barry (1995) the population densities chosen for the present experiments were 32 pairs and then placing the adults in experimental small package contained twenty grams of flour. Each treatment combination was replicated three times.

Larval and pupal duration, adult emergence, bodyweight and mortality rate were recorded every three days.

Analysis of variance was used to analyze the data; means were separated by Duncan's, 1951 multiple range test.

3- Physiological studies

The biochemical studies were carried out in spring. This experiment was conducted to detect cholinesterase activity in the body of adult and young 3rd

instars larvae under different treatments and untreated control (ultrasonic pressure, ultrasonic +24hrs. light, ultrasonic+24hrs. dark and ultrasonic+24hrs. 45C°).

Determination of cholinesterase activity :-

The colorimetric determination of cholinesterase activity was made according to the method of (Ellman *et al.*, 1961).

The principle of this method is the measurement on thiocholine produced from the hydrolysis .

RESULTS AND DISCUSSION

Numbers of escaping insects of flour beetle exposed to Ultrasound and other stresses compared with untreated control beetles are presented in (Table1).

The continued escaping wearing the Ultrasound indicated that the effect on flour beetles may consider as a reason to monitor beetles. The finding as pulsed ultrasound was used with limited success to influence the behavior of various lepidopteran crop pests. Belton and Kempster , (1962) reported that a 63% reduction of the European corn borer, *Ostrinia nubilalis* (Hubner), in sweet corn. Payne and Shorey , (1968) indicated a 31% reduction in oviposition in the cabbage looper, *Trichoplusia ni* (Hubner), in lettuce and broccoli.

Table1:- Cumulative percentages of adult escaping of confuse flour beetle *T.confusum* exposed to ultrasonic Pressure combined with other stresses and untreated control.

Time by minutes	Percentage of escaping adults%				
	Us. alone	Us. +24hrs. light	Us. +24 hrs. dark	Us. +24hrs. 45C°	Untreated Control
	Initial number 30 adults				
60	20	25	20	26	0
90	21	28	22	29	0
120	25	33	25	55	0
150	26	47	30	55	0
180	30	55	35	60	0
210	32	60	36	65	0
240	33	65	38	65	0
270	35	66	45	70	0
300	40	73	50	75	0

US. =Ultrasonic.

Us. alone, Us.+24hrs. light, Us.+24 hrs. dark and untreated control Under 25 ±5C°.

From the presented results in Table 1, the highest percentages of adult escaping of confuse flour beetle was after 5 hours by the active ultrasonic- emitting devices and raising temperature to 45C°, whereas the lowest percentages was after five hours by the active ultrasonic- emitting devices alone. The Ultrasonic devices (Table1) revealed differences in the performance. The considerable difference in sensitivity from the confused flour beetles from the effect of ultrasonic was detected between treatment

combined with raising temperature to 45C° and ultrasonic, the Ultrasonic alone and the untreated control (75%, 40% and 0%), respectively.

The analysis of data indicated a significant increase in the rate of mortality percentage (Table 2) in ultrasonic treatments with clear highly difference in the ultrasonic plus 45C° comparing with untreated control. However, the biological importance of these observation clear to interpret. In the store environment, perceived reductions in the beetle population may satisfy the aesthetic threshold, but the same number of beetles could still exit in the structure but in different locations.

Table2:- Percentage of larval and adult mortality of confused flour beetles (*Tribolium confusum*) exposed to ultrasound and other stresses.

Stage	Mortality% Untreated Control	Mortality% US. Pressure			
		Us. alone	Us. +24rh light	Us. +24rh dark	Us. +24rh 45C°
Larva(3 rd instar)	0.0 a	11b	11.5c	12.9d	29.5e
Adult	0.0 a	7b	8.1c	7.1b	19.5d

US.=Ultrasonic.

Larval and pupal duration , adult emergence in days of beetles exposed to Ultrasound and all stresses differ significantly compared with beetles of untreated control are presented in (Table3). Beetles which continued their life indicated that ultrasonic combined with other stresses affect on confused flour beetle in flour package also by elongated life span. Whereas Silverman and Reiersen, 1981 found that mean larval of flea development time under ultrasound are similar to control while Bruce, 1948 reported that larval development time was less under the same conditions.

A lower body weight were 0.11 gm in beetles exposed to ultrasonic +24hrs. 45C°.The analysis of data indicated highly significant differences between treatments.

Table3:- Development time (duration in days) for larvae, Pupation, emergence and body weight in adult *T. confusum*.

US. Pressure	Larval Duration in (days)	Pupal Duration in (days)	Adult emergence in (days)	Body weight (gm)
US. alone	37.2b	14bc	7.7b	0.12ab
24hrs.ligth+. US	38.1d	14.1c	8.5c	0.13b
US.+24hrs.dark	37.2b	13.8b	8b	0.12ab
US.+24hrs. 45C°	37.6c	15d	8.4c	0.11a
Untreated Control	34.9a	12a	6.2a	0.12ab

US. = Ultrasonic.

Data presented in Table 4, shows that Ultrasonic Pressure combined with other stresses found effective on Nervous System with changes in cholinesterase activity in larvae and adult *Tribolium confusum*., however , Ch.E percentage activities decreased gradually 25, 12 ; 10, 9.5;

8, 6.5; and 4, 4.7% in treated *T. confusum* adults and 3rd instars larvae, respectively, compared with the highest levels 100% in untreated ones.

Table4:- Percentages of Cholinesterase Enzyme in *Tribolium confusum*.

US. Pressure	Ch.E. % in adult	Ch.E. % in Larva (3 rd instars)
US. alone.	25%	12%
24hrs. light +Us.	10%	9.5%
US.+24hrs. dark	8%	6.5%
Us.+24hrs. 45C ^o	4%	4.7%
Control Untreated	100%	100%

US. = Ultrasonic.

Used ultrasonic (ultrasound) to eliminate or manage the *T. confusum* pest in stores and grocery combined by heat of about 45C^o, found as the best safely method to control this pest.

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تأثيرات إنبعاث الموجات فوق الصوتية كنوع من الضغط على التغيرات البيولوجية والفسيوولوجية على خنفساء الدقيق المتشابهة *Tribolium confusum* (du Val) (Coleoptera: Tenebrionidae).

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عرضت خنفساء الدقيق المتشابهة *Tribolium confusum* (du Val) التي غذيت على دقيق قمح على درجة حرارة $25 \pm 5^\circ\text{C}$ لموجات فوق صوتية عنبئة بمعدل 2400-4500 هرتز من جهاز الموجات فوق صوتية على مسافة 50 سم. بالإضافة إلى تعرض الحشرات إلى ظروف بيئية أخرى (إضاءة مستمرة 24 ساعة يوميا، إظلام تام لمدة 24 ساعة و حرارة من مصنر حرارى 45°C لمدة 24 ساعة يوميا).

ويمكن تلخيص أهم نتائج هذا البحث فيما يلي:-

- 1- أعلى نسبة هروب للحشرات كانت للحشرات التي عرضت للموجات فوق صوتية مع حرارة 45°C لمدة 24 ساعة يوميا .
- 2- أعلى نسبة موت أيضا لليرقات والحشرات الكاملة عند التعرض على درجة 45°C لمدة 24 ساعة يوميا ، وأظهر التحليل الإحصائي للنتائج فروق معنوية واضحة بين جميع المعاملات (إضاءة مستمرة 24 ساعة يوميا، إظلام تام لمدة 24 ساعة حرارة من مصنر حرارى 45°C لمدة 24 ساعة يوميا) و الحشرات غير المعاملة (الكنترول).
- 3- أظهرت النتائج أن هناك تأثير للموجات فوق صوتية منفردا ومضاعف عند التعرض إلى 45°C لمدة 24 ساعة يوميا حرارة 45°C لمدة 24 ساعة يوميا على بيولوجيا الحشرة عن طريق إطالة مدة الطور اليرقى والعذراء أيضا سبب نقص فى الوزن الكلى لأجسام الحشرات الكاملة. وأظهر التحليل الإحصائي للنتائج فروق معنوية واضحة بين المعاملات وبين الكنترول.
- 4- أظهرت النتائج ان للموجات فوق صوتية تأثيرا على الجهاز العصبى للحشرة عن طريق إظهار نقص كبير فى نشاط إنزيم الكولين إستريز فى أجسام الحشرات واليرقات المعاملة. ومن التجارب يتضح أن استخدام الموجات فوق الصوتية مع رفع درجة الحرارة إلى 45°C أسلوب آمن لمكافحة خنفساء الدقيق المتشابهة *Tribolium confusum* (du Val) فى المخزن.