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RELATIONSHIP BETWEN CONCENTRATION AND TIME OF EXPOSURE ON THE TOXICITY OF METHYL BROMIDE TO *ACARUS SIRO* L. AND *RHIZOGLYPHUS ECHINOPUS* (F. AND R.) AT DIFFERENT TEMPERATURES.

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Abstract

The interaction between temperature, concentration and period of exposure was studied when using methyl bromide fumigation against the adult and egg stages of *Acarus siro* L. and *Rhizoglyphus echinopus* (F.&R.). The results showed that the egg stage was more tolerant than the adult stage to methyl bromide. The gas becomes more effective against the egg and adult stages as the temperature increased from 10 to 30°C . The effective concentrations decreased in amount as a result of the increase in temperature. The rate of decrease varied form one period of exposure to another, and according to the type of mite tested.

Data showed that *R. echinopus* was more susceptible to methyl bromide than *A. siro* .

INTRODUCTION

Flour, cereal and stored products are subject to attack by a large number of mites belonging to different families. Attiah (1969) recorded and described 10 species belonging to astigmatid mites associated with stored grain in Egypt. According to Hughes (1976), mites occupy a great array of environments and a relatively large number of species live on stored products, including stored grain and seeds, burrowing into and consuming the germ or embryo.

In recent years, increased concern about the loss of stored products through insect and mites infestation has led to greater interest in the use of control meas-

ures, chemical or non-chemical . Among the available chemical measures for this particular purpose, stress must be placed on fumigation. This method is by far, the only practical control measure which up to the present has been found the most effective for quick and complete disinfestation . Methyl bromide can be considered as one of the most effective fumigants to control insects in grains, flour, agricultural products and animal foods (Monro, 1960).

In the present work methyl bromide was used against the mites *A. siro* and *R. echinopus*. The purpose was to test the susceptibility of the egg and adult stages of the two mites to methyl - bromide at different concentrations, exposure time and temperatures.

MATERIALS AND METHODS

The mites used in the present investigation were *A. siro* and *R. echinopus*. For the preparation of pure culture, adults were placed singly in rearing cells and each mite was supplied daily with food . After the females deposited about 25 eggs, they were mounted for identification , thus the eggs of each mite formed the nucleus of its pure culture. *A. siro* was reared on cheese and *R. echinopus* on chocolate in conical flasks sealed with cotton wool plugs. The flasks were kept at $24\pm1^{o}C$ in incubators maintained at 75± 5% R.H. Adult and egg stages were placed in small hemispherical plastic cells of .0.50 inch in diameter and less than 0.25 inch in depth. Bottom of each cell was covered with plaster of Paris mixed with charcoal, and the top of each cell was covered with string.

The fumitaria used for methyl bromide were 5 liter capacity glass containers with rubberized metal screw lids. A perforation about 2mm in diameter was made in the center of the metal lid to enable injecting the dose through the rubber lining by the needle of a gastight syringe . Methyl bromide was drowm directly into the syringe as it evolved as a gas through a rubber tube attached to the top of a container of liquid methyl bromide. Before dosing, the above mentioned reservoir containing the liquid methyl bromide gas was taken out from the freezer and left outside to reach room temperature. Dosing was then achieved by the use of gas tight glass syringe of appropriate size following the technique described as tentative methods for

adults of some major pest species of stored cereals with methyl bromide and phosphine (Anonymous, 1975).

The voulume, d (ml) of methyl bromide vapour at 25°C required to obtain a certain concentration , X_1 (mg/l) in fumigation chamber of a definite voulume,.V_1 (1) was calculated as follows :

$$\frac{298 \times X\ (mg/l) \times V_1\ (1)\ \ 22.414 \times 100}{273 \times 1000 \times 94.939\ (GMW\ methyl\ bromide)} = d1\ (ml)$$

i. e. X_1 (mg / l) x V_1 (l) x 0.2577 = d_1 (ml)

Six concentrations were prepared . Four replicates were run at each exposure period , with each temperature. Each replicate contained 25 individuals . After fumigation, the glass containers were put inside an incubator under constant temperature of 10, 20 and 30°C , for the exposure periods 8, 18 and 24 h.

At the end of each exposure period , the fumitaria were opened and the plastic cells containing the eggs were kept in the breeding room for counting the number of hatched eggs and recording mortality percentages . The adults were transferred on a small amount of cheese or chocolate in small hemispherical plastic cells and covered with a special kind of muslin. The cells were kept at the same conditions of breeding. Mortalities of adults were recorded afer four days from treatment.

According to Paradhan and Govindan (1953/1954) , if the insects are fumigated at temperatures different from those under which they have been reared, mortality results might be misleading due to changes in the uptake of the fumigant which depends on insects physiological activity.

In the present work, when fumigation was conducted at 10, 20 and 30°C the tested mites were moved progressively before and after treatment in steps of 5°C for 12h each then held at the rearing temperature until mortality assessment.

Mortalities in fumigated batches were corrected for natural mortality in the control then subjected to probit analysis to calculate the regression equations, slopes and the values of LC_{50} , LC_{90} LT_{50} and LT_{90}. Least significane difference due to the different factors was considered in this study.

Table 1. Slope of regression line, LC_{50} and LC_{90} values of methyl bromide for adult and egg stages of *Acarus siro* and *Rhizoglyphus echinopus* at different temperatures and different periods of expoure.

Temp.	Stages	Time (h)	Acarus siro			Rhizoglyphus echinopus		
			Slope	LC_{50} mg/l	LC_{90} mg/l	Slope	LC_{50} mg/l	LC_{90} mg/l
10°C	Adult	8	3.810	4.65	10.07	3.764	3.86	8.44
		18	2.75	2.50	4.98	3.035	3.32	8.51
		24	2.009	1.00	4.22	4.638	2.26	5.26
	Egg	8	2.619	5.12	8.64	3.927	2.68	5.68
		18	6.409	4.25	6.73	2.192	0.90	3.46
		24	3.449	3.09	6.79	3.106	0.68	1.76
20°C	Adult	8	4.022	3.62	7.53	4.763	2.81	5.21
		18	3.524	1.53	3.53	2.554	2.05	6.49
		24	2.660	0.85	2.49	2.741	1.62	4.75
	Egg	8	2.595	3.18	9.89	2.765	1.69	4.92
		18	6.346	3.47	5.53	2.445	0.71	2.37
		24	3.725	2.36	5.20	2.104	0.46	1.86
30°C	Adult	8	4.101	2.28	4.68	2.963	2.26	6.11
		18	2.551	0.94	3.03	2.745	1.62	4.74
		24	2.006	0.40	1.72	2.835	0.90	2.25
	Egg	8	2.299	2.24	8.05	2.71	1.31	3.89
		18	3.020	1.78	4.74	2.492	0.61	1.91
		24	2.915	1.56	4.29	2.245	0.37	1.39

RESULTS AND DISCUSSION

As demonstrated in Table 1, the egg and adult stages of *A. siro* and *R. echinopus* became more susceptible to methyl bromide at the three temperatures when the time of exposure increased from 8 to 24h. It also appeared that the rate of decrease in the LC_{50} and LC_{90} values as the period of expousre increased within each category was not constant.

For the tested stages of *A. siro* an *R. echinopus* at the three temperatures studied, the decrease in concentration was more rapid as the period of exposure increased from 8 to 18 h than from 18 to 24 h. This is indicated by comparing the averages of LC_{90} values for each stage at each period of exposure calculated across the three temperatures. These averages (Table 2) show the change in the rate of decrease of concentration required to kill 90% of the egg and adult stages when the period of exposure increased from 8 to 24 h. This observation however does not apply on eggs of *R. echinopus.*

At the average of LC_{50} level , significant differences were detected for eggs of *A. siro* when comparisons were made between the two periods of exposure 8 & 24 h. Significant differences were also observed for adults when comparison was made between the exposure periods 8&18 and 8&24h. The same trend was also indicaed for eggs at the LC_{90} level and at the same periods of exposure . Similarly, and at the LC_{50} level , adults of *R. echinopus* showed significant differences at the periods of exposure 8&18h when compared with 8&24h. Points of significance were also detected in case of eggs compared at 8&18 and 24h.

Data in Table 2 show that methyl bromide becomes more toxic to the egg and adult stages of *A. siro* and *R. echinopus* as the temperature increased from 10 to $30^{o}C$; this is indicated by comparing the values of LC_{50} and LC_{90} across the periods of exposure for each temperature.

Methyl bromide in general becomes less effective against the egg and becomes more effective against the adult stage. The interaction between temperature, concentration and period of exposure (Table 1) show clearly that there was a decrease in concentration with the increase in temperature , but the rate of such decrease varied from one period to another. Fore example, in case of adults of *A. siro* at $10^{o}C$, the LC_{50} value was about 2.04 times the value at $30^{o}C$ when the period of

Table 2. Averages of LC_{50} and LC_{90} values of different temperatures for the adult and egg stagfes of *Acarus siro* and *Rhizoglyphus echinopus* fumigated with methyl bromide.

Species	Temp. (°C)	Adult		Egg	
		Avg. LC_{50} mg/l	Avg. LC_{90} mg/l	Avg. LC_{50} mg/l	Avg. LC_{90} mg/l
A. siro	10	2.72 n. s.	6.42 n. s.	4.15 n. s.	7.45 -
	20	1.99 n. s.	4.52 n. s.	3.00 n. s.	6.87 -
	30	1.21 **	3.14 **	1.86 **	5.69 n. s.
	L.S.D. 0.05	1.03	2.15	1.01	-
R. echinopus	10	1.42 -	3.64 n. s.	3.11 ***	7.40 n. s.
	20	0.95 -	3.05 n. s.	2.16 ***	5.48 n. s.
	30	0.76 n. s.	2.40 **	1.59 ***	4.37 **
	L.S.D. 0.05	-	2.40	0.32	2.19

exposure was 8 h, and was 2.5 times its value when the period of exposure was 24h.

Fumigation tests with methyl bromide against the two stages of *A. siro* and *R. echinopus* over a wide range of combinations of concentration and periods of exposure at 10, 20, 30°C, revealed that the rate of decrease in concentration due to the increase of the period of exposure was not constant throughout the range of periods of exposure studied .

Lindgren *et al.*, (1954) studied the relative effectiveness of ten fumigants to adults of eight species of stored product insects and found that the LC_{50} and LC_{90} values of methyl bromide for the adults of *Tribolium confusum* were 3.5 & 3.2 times greater at 2h than at 6h, indicating that the LC_{50} and LC_{90} values decreased with increasing the period of exposure. The studies of Lindgren and Vincent (1959) on the effect of periods of exposure at different temperatures on the control of the Khapra - beetle larvae by use of methyl bromide, agree with the present work in that the dosage necessary for 100% kill decreased with increasing the period of exposure from 2 to 48h at the three temperatures studied. The same authors studied the toxicity of methyl bromide at various temperatures and exposure periods to four stages of *Trogoderma variable* and found that the fumigant became more effective as the exposure time increased.

Nakhla (1983) studied the different factors which affect the efficiency of atmospheric fumigation on *T. confusum* and *Latheticus oryzae*. He found that the rate of decrease in concentration with the increase of period of exposure was not constant through the range of periods studied (8-48 h). Generally, methyl bromide becomes less effective against the egg and adult stages of *A. siro* and *R.echinopus* as the temperature decreased from 30 to 10°C .

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العلاقة بين التركيز وفترة التعريض علي سمية غاز بروميد الميثايل علي أكاروس *Rhizoglyphus echinopus, Acarus siro* وذلك علي درجات حرارة مختلفة

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معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي

تم دراسة تأثير التداخل الثلاثي بين الحرارة والتركيز وفترة التعريض عند استخدام غاز بروميد الميثايل ضد الطور البالغ والبيض للأكاروس ***Rhizoglyphus echinopus, Acarus siro***

وقد أوضح الاتجاه العام للنتائج أن طور البيضة أكثر تحملا لغاز بروميد الميثيل عن الطور الكامل، كما يزداد تأثير الغاز بزيادة درجات الحرارة من ١٠ الي ٣٠°م في طوري البيضة والطور الكامل، وتؤدي الزيادة في درجات الحرارة الي النقص في معدلات تركيزات الغاز المستخدمة ولكن معدل هذا النقص في التركيزات يختلف من فترة تعريض الي أخري.

وأيضا بالنسبه للأكاروس المستدخم ... أوضحت النتائج أن الأطوار المختلفة للنوع *R. echinoups* كانت أكثر خساسية عنه في أطوار النوع A. siro.