

## EFFECT OF ECO<sub>2</sub>- FUME GAS AS AN ALTERNATIVE OF METHYL BROMIDE ) AGAINST TROPICAL WAREHOUSE MOTH *EPHESTIA (CADRA) CAUTELLA* (HUBM) AT EL-KHARGA OASIS, NEW VALLEY, EGYPT

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### **Abstract**

This study aimed to investigate, for the first time in Egypt, the efficacy of ECO<sub>2</sub>-Fume fumigant gas (2% PH<sub>3</sub> + 98% CO<sub>2</sub> w/w) at five concentrations ( 300,400,500,600 and 700 ppm) against immature stages of *E. cautella* (Hubm), (Eggs, Larvae and pupae) at 28 ± 1 C<sup>0</sup> and 60 ± 5 % RH at el Kharga Oasis , New Valley Governorate, 10/4/2011.

The results indicated that, egg hatchability and mortality of larvae and pupae were clearly affected with gas concentrations. The same results were found in percent reduction in F1-Progeny. The convenient dose of ECO<sub>2</sub> – Fume gas against all developmental stages of *E.cautella* was 500 ppm (36 g/m<sup>3</sup>) for 3 days exposure.

The results also indicated clearly that, percent infestation in tamr El- Wady increased in date without capsul by this pest. And the effect of gas 100 % mortalities on the pest in date with and without capsul.

### **INTRODUCTION**

The almond moth, *Ephestia cautella* is a major world wide pest of stored food, it occurs both in tropical and temperate regions and commonly attacks grains, nuts, dried fruits and a great variety of other stored products.

The date crop of Kharga Oasis suffers annually to a very considerable extent from the ravages of the larvae of an *Ephestia* , feeding in the interior of the dates, reduce the value of the fruit (Gough, 1917) , food consumption, Ali, et.al. (2003) stated that semi-dry dates were the most injurious by *E-calidella*, *E-cauttella* and *O.surinamensis* through storage. Also, Ali, et.al. (2001/2002) stated that date fruits pests cause 20-73.3% loss of tamr annually, consequently shortage production. Mewtally, et.al. (2007) reported that approximately 50% of stored dates were lost after elapsing 6-7 month of storage.

Methyl bromide is a halogenated compound in Ozone depletory (Tyler, 1994) and is suspected carcinogen.

Tsvetkov and latif (1987) studied the average number of eggs per female of *E.cautella* under optimum conditions of 26 C<sup>0</sup> and available water was 383.3 while the

maximum number laid was 738, also they recorded that the pest had 4-10 generation per year at temperature ranging from 18 to 34 C° .

Eissa (2003) stated that the mean number of eggs laid by a single female of *E.cautella* during its whole life ranged between 52.38 and 159.29 eggs. Also, reported that *Ephestia calidella* and *E.cautella* larvae attack the immature and mature dates on the trees and in the stores.

El-Assal (2004) carried out experiment on biology of *Ephestia cautella* under mean laboratory condition. From March 1997 to February 1998. He found that the total number of eggs laid per female varied from 142.7 to  $189.9 \pm 97.8$  eggs. The adult longevity ranged between 4-7 days. *E.cautella* recorded 6 larval instars. *Cadra* spp (*cautella* and *calidella*) are considered serious pests decreasing the exporting value as well as the profits. A semifull biological study of *E.cautella* were done in the New Valley by Saleh 1974.

## MATERIALS AND METHODS

### **Insect culture:**

Eggs, Larvae and Pupae of the almond moth, *E.cautella (Hubm)* were taken from a laboratory culture as follows:

Larvae of this insect were obtained from fallen date fruits, after harvesting at El-Kharga Oasis:-

The collected larvae were put on dry dates, Tamr El-Wady variety, in plastic jars (2 KG capacity) covered with muslin cloth and secured with rubber bands, then kept at  $28 \pm 1$  C° and  $60 \pm 5$  % RH till adult emergence. The emerged adults were collected daily by a glass tube and placed in new glass cages with screen bottom to obtain eggs. The eggs were collected daily in betri dishes and transferred to a plastic jar contains 3.KGs of dry date fruits. The deposited eggs and newly hatched larvae were used to infest healthy date fruits with or without capsules used in fumigation experiments at the desired age of eggs, larvae or pupae.

### **Artificial infestation:-**

Numbers of eggs, larvae and pupae were used to infest date fruits to carry out the following experiments:

### **Fumigation technique:**

Two tons of fruit date, Tamr El-Wady variety were divided into six equal quantities (piles) each was specialized for a concentration of  $\text{CO}_2$  – Fume. Each pile was also distributed into 18 plastic boxes (50 x 30 x 30 cm each ) as 18.5 kg for each. The boxes of each pile were put together in three layers on a concrete floor.

A group of 30 eggs (24 h old) was distributed on 250 gm of date fruits found in a cloth bag then tightly closed represented a replicate. Twelve replicates were distributed, on the middle layer of each pile as three bags in each direction.

By the same way, similar 12 cloth bags each contained 250 gm date fruits harbored larvae ( 10-11 days old) and another 12 bags harbored pupae (2-4 days old) were also distributed at the same sites as before in each pile. The pile was covered with a suitable plastic sheet and tightly fixed as followed with dry sand.

Five concentrations (treatments) of  $\text{ECO}_2$  – Fume gas, 300, 400, 500, 600 and 700 ppm were used as one for a pile. The sixth pile was left without gas treatment as a control.

The fumigation was continued for three days then the cover sheet was removed and the pile was left to be aired. The treated date samples were thoroughly transferred into suitable glass jars and covered with muslin then kept in incubators adjusted at  $28 \pm 1 \text{ C}^\circ$  and  $60 \pm 5 \%$  RH.

Three groups of date fruits with capsules, 100 each, were taken before fumigation. Another three similar groups without capsules were also taken by the same way before treatment. In the same time, three similar groups of capsule fruits and another three ones without capsules were also taken from each concentration after gas treatment.

All Jars were put under daily observation till 45 days after distribution to record the emerged adults and calculate percent mortalities according to abbots formula as follows:

$$\% \text{ Mortality} = \frac{(\text{AC}-\text{AT})}{\text{AC}} \times 100$$

AC: No. of adults emerged in control

AT: No. of adults emerged in treatment

For calculating the required dose (300, 400, 500, 600 and 700 ppm), the dimensions of each pile was measured and the needed quantity of  $\text{ECO}_2$ -Fume was taken as follows:-

- Raise the cylinder onto a platform digital balance and note the weight.
- Open the cylinder valve
- Watch the weight of the cylinder and close the valve when the required dose according to tables recommended is delivered.
- Disconnect the cylinder after closing the cylinder valve
- Measured the  $\text{ECO}_2$ -Fume gas at the fumigation period by using silo check.

## RESULTS AND DISCUSSION

Effects of  $\text{ECO}_2$  -Fume, in different concentrations, on different immature stages of *E.cautella* are illustrated as follows:

### 1-Effect on eggs:

Data found in table (1) indicated that, egg hatching was greatly affected with the gas treatment. It recorded 36.3 and 17.2 % opposite at the concentration of 300 and 400 ppm respectively. No hatching was observed (0.0 %) at the higher concentration up to 400 ppm.

Table 1. Effect of  $\text{ECO}_2$  -Fume gas against eggs:

Gas concentration (ppm)	% Hatching	No. of F1-progeny after 45 days(adults)	% Reduction in F1-progeny
300	36.3	10.3	58.3
400	17.2	5.3	78.5
500	0.0	0.0	100
600	0.0	0.0	100
700	0.0	0.0	100
Control	80.7	24.7	0.0

### 2-Effect on larvae:

The results of the effect of the fumigant gas against the larvae are presented in table 2. The results of reduction % in F1-progeny were concentration dependent. Reduction in F1-progeny was ranged between 68.2-100% for the various tested concentration of  $\text{ECO}_2$  -Fume gas.

Table 2. Effect of  $\text{ECO}_2$  –Fume gas against Larvae

Gas concentration (ppm)	No. of F1-progeny (adults)	% Reduction in F1-progeny
300	9.0	68.2
400	4.0	85.9
500	0.0	100
600	0.0	100
700	0.0	100
Control	28.3	0.0

**3-Effect on pupae:**

The results are shown in table 3, that reduction in F1-progeny was also increased by increasing the gas concentration. It ranged 46.9-100% for the concentrations between 300-500 ppm. The results showed also a complete inhibition for the eggs, larvae and pupae exposed to the tested gas at 500 ppm.

Table 3. Effect of  $\text{ECO}_2$  –Fume gas against pupae

Gas concentration (ppm)	No. of F1-progeny (adults)	% Reduction in F1-progeny
300	14.7	46.9
400	7.7	72.2
500	0.0	100
600	0.0	100
700	0.0	100
Control	28.3	0.0

#### 4-Mortality of larvae and pupae:

Data tabulated in table 4 shows for the efficacy of  $\text{ECO}_2$ -Fume against *E. cautella* larvae and pupae was concentration dependent the recorded mortality after 3 days exposure after treatment with 300 ppm.

Table 4. Effect of  $\text{ECO}_2$ -Fume gas on the mortality of larvae and pupae:

Gas concentration (ppm)	Before Treatment						After Treatment							
	Larvae %			Pupae %			I %	Larvae %			Pupae %			I %
	A%	D%	M%	A%	D%	A%		D%	M%	A%	D%	M%		
300	2.3	0.0	0.0	1.7	0.0	16.0	3.7	1.3	35.1	2.3	0.7	30.4	14.0	
400	4.3	0.0	0.0	2.3	0.0	14.0	2.3	1.7	73.9	3.3	1.7	51.5	13.0	
500	3.7	0.0	0.0	2.7	0.0	14.0	0.0	4.3	100	0.0	0.7	100	16.3	
600	3.3	0.0	0.0	2.0	0.0	17.0	0.0	6.7	100	0.0	0.0	100	16.0	
700	3.7	0.0	0.0	0.0	0.0	6.7	0.0	2.7	100	0.0	1.3	100	8.3	
Control (untreated)	3.3	0.0	0.0	0.0	0.0	15.0	2.7	0.0	0.0	1.3	0.0	0.0	12.8	

A %: Alive

M %: Mortality percent

D %: Dead

I %: Infestation percent

35.1 And 30.4 % for Larvae and Pupae respectively.

This values increase to 100 and 100% for larvae and pupae respectively at 500 PPM concentration of  $\text{ECO}_2$ -Fume.

#### 5-Effect on larvae and pupae in capsuled and incapsuled date fruits:

Table 5 showed that complete mortality at 500,600 and 700 ppm concentration of  $\text{ECO}_2$ -Fume gas for Larvae and pupae but 300 and 400 ppm concentration gave 56.5, 88.2 for larvae and 52.6, 76.5 for pupae in fruits without capsule.

Table 5. Effect of ECO<sub>2</sub>-Fume gas on mortality of larvae and pupae in Date without capsule and date fruits with capsule.

Gas  Concentration (ppm)	Date without capsul (100 fruits)							Date with capsul (100 fruits)						
	Larvae %			Pupae %			I %	Larvae %			Pupae %			I %
	A%	D%	M%	A%	D%	M%		A%	D%	M%	A%	D%	M%	
300 ppm	2.3	1.3	56.5	1.9	1.0	52.6	24.0	1.3	0.7	76.9	0.3	0.1	33.3	6.7
400 ppm	1.7	1.5	88.2	1.7	1.3	76.5	27.0	1.7	1.4	82.4	0.1	0.1	100	7.3
500 ppm	0.0	3.7	100	0.0	0.3	100	26.0	0.0	2.3	100	0.0	0.0	100	6.3
600 ppm	0.0	3.3	100	0.0	0.7	100	27.7	0.0	1	100	0.0	0.3	100	3.7
700 ppm	0.0	2.7	100	0.0	1.0	100	30.7	0.0	1.7	100	0.0	0.3	100	3.3
Control (untreated)	1.3	0.0	0.0	0.0	0.0	0.0	22.7	1	0.0	0.0	0.7	0.0	0.0	3.7

A %: Alive

M %: Mortality percent

D %: Dead

I %: Infestation percent

The concentration of 500, 600 and 700 ppm gave complete mortality for larvae and pupae in fruits without capsul but 300 and 400 ppm gave 76.9, 82.4, 33.3 and 100 for larvae and pupae in the fruits with capsul, respectively. The infestation rate in samples fruits without capsule ranged between 22.7-30.7% but in case of fruits with capsule.

Ranged between 3.3-7.3 %. This results indicated clearly that cap protect dry date Tamr El-Wady from infested By *Ephestia cautella* in storage. The obtained results are in harmony with the findings of other investigators on the efficacy of combinations of phosphine plus carbon dioxide against some stored product insects ( Winks, 1982 and 1984, Desmarchelier, 1989 and El-Lakwah *et al.*, 1989,1991 a,b and 1992 a, b and c )

6-Concentration of ECO<sub>2</sub>-Fume gas under the plastic sheet

Table 6. Concentrations of ECO<sub>2</sub>-Fume gas (ppm) under the sheet through 3 days exposure.

Gas concentration (ppm)	Period of exposure				
	Initial time	1 <sup>st</sup> day	2 <sup>nd</sup> day	3 <sup>rd</sup> day	Average
(21 g / m <sup>3</sup> ) 300	560.9	431.3 (23.08)	347.0 (38.14)	230.7 (59.00)	393.4 (30.12)
(28 g / m <sup>3</sup> ) 400	595.0	435.0 (26.85)	367.0 (30.32)	231.0 (61.18)	407.0 (29.86)
(35 g / m <sup>3</sup> ) 500	927.5	510.0 (45.01)	314.5 (66.09)	252.5 (72.78)	501.1 (45.97)
(42 g / m <sup>3</sup> ) 600	947.5	574.5 (39.37)	312.0 (67.07)	304.0 (67.92)	534.5 (43.59)
(50 g / m <sup>3</sup> ) 700	995.0	637.5 (35.93)	557.5 (43.97)	460.0 (53.77)	547.5 (44.97)

Numbers between brackets represent % reduction.

Data found in table (6) revealed that all gas concentrations decreased gradually through the period of exposure. While they were 590.9, 595.0, 927.5, 947.5 and 995.0

ppm at the initial time, they decreased with about 23.08 – 45.0 %, 38.14 – 66.09 % and 59.00 – 72.78 % through the three successive days of exposure, respectively.

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تأثير غاز الإيكوفيوم كبديل لغاز بروميد الميثيل ضد فراشة البلح العامري  
*E.cautella* علي البلح المخزن في الواحات الخارجة  
 بمحافظة الوادي الجديد - مصر

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تهدف هذه الدراسة الي تقييم فاعلية غاز الايكوفيوم ( ٢% فوسفين + ٩٨% غاز ثاني أكسيد الكربون وزن/وزن ) تركيزات ٣٠٠، ٤٠٠، ٥٠٠، ٦٠٠، ٧٠٠ جزء في المليون أي ٢١، ٢٨، ٣٥، ٤٢، ٥٠ جم/م<sup>٣</sup> و قد أجريت هذه الدراسة ضد فراشة البلح العامري على البلح الجاف في المخزن على درجة حرارة ٢٨±١ م° و رطوبة نسبة ٦٠ ± ٥% بالواحات الخارجة في محافظة الوادي الجديد ٢٠١١

و قد أظهرت النتائج زيادة في نسبة موت أطوار الحشرة تحت الدراسة بيض - يرقات - عذارى بزيادة تركيز الغاز و لمدة تعريض ٣ أيام و كذلك النقص في تعداد أفراد الجيل الأول حيث أعطى التركيز ٣٥ جم (500 ppm) لكل متر مكعب فراغ إيادة كاملة لجميع أطوار الحشرة خلال ثلاثة أيام تعريض و بزيادة التركيز عن ٣٥ جم/م<sup>٣</sup> أعطى نفس النتائج و لذلك نوصي باستخدام التركيز ٣٥ جم/م<sup>٣</sup> لإبادة جميع أطوار الحشرة تحت الدراسة عند درجة حرارة ٢٨±١ م° و ٦٠ ± ٥% رطوبة نسبية سواء في عينات الحشرات الصناعية (بيض- يرقات- عذارى) و كذلك العينات العشوائية المأخوذة من البلح المصاب قبل و بعد التبخير.

وقد أوضحت النتائج :

أن نسبة الإصابة بالحشرة تحت الدراسة في البلح الجاف بدون كبسول أعلى من البلح الجاف الذي يحتوي على كبسول لضعف هذا المكان في الثمرة حيث يسهل منه دخول اليرقة داخل البلحة فتصاب و تكمل دورة الحياة مما يقلل من كفاءة تصدير البلح للخارج .