

## Chemical Control of Angoumois Grain Moths, *Sitotroga cerealella* Olivier (Lepidoptera : Gelechiidae).

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### ABSTRACT :

Treatment of the wheat grain containing both larval and pupal stages of *Sitotroga cerealella* Olivier with the synthetic pyrethroids, cypermethrin, deltamethrin and fenpropathrin at a concentration of 5 ppm resulted in reduction in adult emergence of 72.9, 79.9 and 49.8 percent respectively.

At concentration of 20 ppm of the JHA, fenoxycarb, the angoumois grain moth was completely controlled. Also, the JHA, MV 678 application resulted in 99.2% reduction adult emergence. Both the IGRs, XRD 437 and chlorfluazuron reduced the adult emergence by 89.8 and 86.7% respectively.

The superiority of either the cypermethrin and deltamethrin or the IGRs over the organophosphates, malathion and karphos is clearly demonstrated in reducing the adult emergence.

**Key words :** Angoumois, grain, moth, *Sitotroga cerealella*, chemical, control.

### INTRODUCTION

The Angoumois grain moth, *Sitotroga cerealella* Olivier, is an important pest of corn, rice and wheat. However, relatively little toxicological informations are available regarding the control of this insect, except for that compiled from tests with malathion and synergized pyrethrum that were not designed to evaluate the

effectiveness of these materials on grain already infested with the moth.

Malathion is often used to protect stored products from insect infestation (Storey et al. 1982). However, its rapid breakdown under conditions of high alkalinity or high grain moisture content and incidence of resistance appearing in strains of both stored product insects belonging to Coleoptera (Haliscak and Beeman 1983) and Lepidoptera (LaHue 1969, Zettler et al. 1973, Zettler, 1974 and Beeman et al. 1982) emphasize the need for finding other insecticides.

Strong and Diekman (1973) screened 15 insect growth regulator compounds against 12 pests of stored products. McGregor and Kramer (1975) studied the activity of both methoprene and hydroprene and their mixtures on several stored grain insects.

The objective of this study was to evaluate three new JHAs and five IGRs beside three synthetic pyrethroids as alternative candidate protectants of wheat against the Angoumois grain moth.

## MATERIALS AND METHODS

The Angoumois grain moth were reared in the laboratory at 27 C<sup>o</sup> and 65% RH. Every jar containing 0.5kg of the clean, uninfested wheat grain was provided with 25 adults from each sex. The moths were left for an oviposition period of three days. The grain upper layer of about 4 cm depth was kept and the other was discarded. The same number of adults was added to the same amount of grain two weeks to obtain grain containing larval or pupal stages of S. cerealella. The infested grains were divided then distributed into small jars each containing 100 g of grain. The insecticides tested in this experiment (in table 1) were prepared in acetone and applied to the grain at 0.05, 0.5 and 5 ppm wt/wt for the pyrethroid and organophosphate compounds and at 1, 10 and 20 ppm for the insect growth regulators. The solutions were first mixed into the food manually and then in a rotating flash evaporator at 40 rpm to remove the acetone.

Table (1) The pesticides tested are :

		<u>Source</u>	
1. <u>Pyrethroid compounds</u>			
a.	Cypermethrin	Cymbush	10% EC ICI Co.
b.	Fenpropathrin	Meothrin	20% EC Sumitomo Co.
c.	Deltamethrin	Rup 962	2.5% EC Roussel Uclaf Co.
2. <u>Organophosphorus compounds</u>			
a.	Isoxathion	Karphos	50% EC Sankyo Co., Ltd.
b.	Karpophos	Malathion	57% EC American - Cyanamid Co.
3. <u>Insect growth regulators</u>			
a.	Dowco-439	Dowco 439	5% EC Dow Co.
b.	Chlorfluazuron	IKI 7899	5% EC ICI Co.
c.	Flufenoxuron	Cascade	5% EC Shell Co.
d.	Triflumuron	BAY SIR 8514	6.5% EC Bayer Co.
e.	XRD 437	XRD 437	5% EC Dow Co.
4. <u>Juvenile hormone analougs</u>			
a.	Fenoxycarb	RO-13-5223	25% WP Dr. Maag Co.
b.	Pro-Drone	MV 678	48% EC Stauffer Co.
c.	R-20458	R-20458	48% EC Stauffer Co.

Tests carried out by Loschiavo, (1976) using a dye showed that this mixing method increased the probability of uniform distribution of the compounds in the food. Untreated and acetone treated grain were used as controls. Treated grain containing the two insect larval and pupal stages was placed in covered jars and examined after 2 weeks then daily until the emergence of all adults in each jar. Numbers of emerged adults were counted and the percent reduction in adult emergence were calculated as follows :

$$\% \text{ Reduction} = 100 \left( 1 - \frac{t}{c} \right) \text{ (Abbot formula, 1925)}$$

t = number of F<sub>1</sub> adult emerging in the treatment

c = number of F<sub>1</sub> adult emerging in the check.

## RESULTS AND DISCUSSION

High reduction in adult emergence was achieved by three pyrethroids at the three concentration levels 0.05, 0.5 and 5 ppm (table 2). Malathion is usually used as a standard for comparison, since it has been the stored-grain insecticide of choice in several countries over the past decade because of its high toxicity to a wide range of stored-product insects and its low mammalian toxicity (Martin and Worthing 1977). In this study, the standard compound, malathion, reduced the progeny number by 11.4 % only. However, a concentration as low as 0.05 ppm of deltamethrin caused a percent reduction in the adult emergence of 31.4 and up to 79.6 at 5 ppm. Malathion was the least effective insecticide among the treated compounds. Isoxathion achieved 29.4% reduction in adult emergence with the concentration of 5 ppm. Cogburn *et al.* (1983), studying the population of Angoumois grain moths developed in untreated rice and in rice treated with malathion found that populations were larger in malathion treated rice than in controls.

The present results revealed that the number of adults emerged from both applied low concentrations of malathion 0.05 and 0.5 ppm was mostly equal to that obtained from untreated grain. In contrast, good results were achieved by using cypermethrin and deltamethrin at 5 ppm supporting its use as a protectant against the angoumois stages inside the wheat grain.

Table 2. Percent reduction in adult emergence as a criterion for the effect of three synthetic pyrethroids and two organophosphates on the immature stages of *S. cerealella*.

Treatments	Concentrations ppm of the tested pesticides					
	0.05		0.5		5	
	Mean No.*	% Reduction	Mean No.*	% Reduction	Mean No.*	% Reduction
<u>Synthetic pyrethroids</u>						
Cypermethrin	186	27.1	114	55.3	69	72.9
Fenpropathrin	254	0.0	188	26.3	128	49.8
Deltamethrin	175	31.4	109	57.3	52	79.6
<u>Organophosphates</u>						
Isoxathion	243	4.1	195	23.5	180	29.4
Karpophos	262	0.0	256	0.0	226	11.4

The mean number of adults emerged from the untreated wheat grain = 255 adults

\* Four replicates were used for each concentration.

As for the IGRs tested (table 3), it was apparent that emergence was completely inhibited by the concentration of 20 ppm of fenoxycarb. Moreover, treatment with as little as 1 ppm of the compound caused a 95.3% reduction in the adult emergence. This compound was the best one in this respect when compared with the other tested IGRs which have the juvenile hormone activity or not. Also, good reduction percentages of adult emergence were achieved with both XRD 437 and chlorfluazuron at 20 ppm. Thomas and Bhatnagar-Thomas (1968) and Bhatnagar-Thomas (1973) reported the use of an IGR JH analogue as an insecticide for pests of stored grain. Others also evaluated such compounds to be used as stored grain products against different insects (Metwally et al. 1972, Amos et al. 1974 and Hoppe 1974). From our present results and of others, the IGRs with a juvenile hormone activity such as fenoxycarb and MV 678 show promise as commodity protectants since they might prevent the development of the population of S. cerealella in stored grain when mixed with the whole wheat grain. However, its full potential as a grain protectant needs additional field trials and long-term toxicological studies. Kramer et al. (1985) reported that fenoxycarb is the compound that comes closest to satisfying the criteria for an ideal grain protectant. Also, they mentioned that fenoxycarb is very active as a population suppressant of stored grain insects.

The high effectivity of the tested IGRs particularly the JHA, fenoxycarb, on the immature stages of insect inside the grain probably due to, to some extent to its movement from external to internal portions of the kernel. There was a significant decrease in the amount of fenoxycarb present in the bran fraction (Kramer et al. 1985). Doubtless, the chemical protectants are oftenly used to prevent the insect infestations and damage to the different commodities during storage and marketing. If these chemicals, are to be used, they must be greatly effective against the target insect, not phytotoxic, and safe to human and the environment. Malathion, synergized pyrethrins and B. thuringiensis, although, are approved for direct application to the grain to limit insect pest infestation during storage, (Redlinger, 1962, Highland et al. 1977 and McGaughey 1978), none of these insecticides fulfill this purpose. Pyrethrins have a limited use in this respect and are expensive. Bacillus thuringiensis,

Table 3. Percent reduction in adult emergence as a criterion for the effect of different insect growth regulators on immature stages of *S. cerealella*.

Treatments	Concentrations ppm of the tested IGRs					
	1		10		20	
	Mean No.*	% Reduction	Mean No.*	% Reduction	Mean No.*	% Reduction
<u>Benzoylphenyl urea</u>						
Dowco 439	229	10.2	210	21.2	105	58.9
Chlorfluazuron	177	30.6	117	54.1	34	86.7
Flufenoxuron	223	12.6	146	42.7	56	78.0
Triflumouron	198	22.4	160	37.3	113	55.7
XRD-437	213	16.5	126	50.6	26	89.8
<u>Juvenile hormone analogues</u>						
Fenoxycarb	12	95.3	2	99.2	0	100
MV-678	89	65.1	17	93.3	2	99.2
R-20458	198	22.4	166	34.9	126	50.6

The mean number of adults emerged from the untreated wheat grain = 255 adults.

\* Four replicates were used for each concentration

is generally inactive against Coleoptera. Moreover, methoprene, in spite of its excellent potential to protect the grain, it exhibits relatively poor activity against Sitophilus species (Mian and Mulla 1982 a,b and Edwards and Short 1984). Therefore, seeking for other alternative compounds to be used and had an apparent effect against the stored product insects of Coleoptera and Lepidoptera is highly recommended. Fenoxycarb that had good effect on Angoumois moth as is shown in this study, it also gave similar good influence on internal feeding Coleopteran insects (Kramer et al. 1981).

In conclusion among the material evaluated in this study, fenoxycarb and MV-678 are the compounds that satisfactorily fulfill our requirements and therefore can be used as a grain protectant against S. cerealella.

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## المكافحة الكيميائية لفرشة الحبوب

ملخص :

إستخدام في هذا البحث مجموعة متباينة من المركبات وهي تشمل :

١- منظمات نمو حشرية وهي تشمل :

أ- مواد مانعة للإنسلاخ :

Flufenoxuron - Chlorfluazuron - Dowco 439 - XRD 437 -  
Triflumuron .

ب - مواد تتمتع بالنشاط الهرموني :

R 20458 - Mv - 678 - Fenoxycarb

وتم تطبيقها بتركيزات ١ ، ١٠ ، ٢٠ جزء / مليون .

٢ - بيروثرايدات مصنعة : وهي تشمل :

Deltamethrin - Fenproathrin - Cypermethrin

وتم تطبيقها بتركيزات ٠,٥ ، ١,٥ ، ٥ جزء / مليون .

٣- مركبات فوسفورية وهي تشمل :

Isoxathion - الملاثيون ( karpophos )

وتم تطبيقها بتركيزات ٠,٥ ، ١,٥ ، ٥ جزء / مليون .

تم دراسة تأثير هذه المواد على الأطوار الغير الكاملة لفرشة الحبوب بداخل الحبوب وإستخدم التأثير في تشبيط معدل خروج الفراشات كقياس للمفاضلة بين هذه المواد واتضح ما يلي :

- حقق كل من deltamethrin ، cypermethrin تأثيرا ملحوسا على خروج الفراشات بينما لم يتمكن من ذلك إلا fenproathrin حتى عند التركيز المرتفع منه ( ٥ جزء / مليون ) .

\* حقق منظم النمو الحشري الهرموني fenoxycarb تشبيطاً كاملاً لخروج الحشرات الكاملة وذلك عند التركيز ٢٠ جزء / مليون وكان المركب mv-678 تقريبا مماثلاً له في هذا الصدد حيث كان التشبيط من خروج الفراشات ٩٩,٢ ٪ عند نفس التركيز .

\* حقق أيضا كل من xrd437 - chlorfluazuron تشبيطاً في خروج الفراشات بمقدار ٨٩,٤ ٪ للأول ، ٨٦,٧ ٪ للثاني .

وعصوما سواء بالنسبة لمنظمات النمو الحشرية أو البيروثرايدات المصنعة فقد حققت تأثيراً أفضل من المركبين الفوسفوريين - والتشبيط التام في خروج الفراشات أو المرتفع والذي تحقق مع بعض المواد كما سبق عرضه تحدد من إمكانية الإصابة للحبوب مرة أخرى يهدد الحشرة الشديدة للضرر .