J.Pest Cont. & Environ. Sci. 8 (1) : 41 – 64 (2000).

RESIDUAL EFFECT OF CYANOPHOS(OP) ON THE GRANARY WEEVIL, *Sitophilus granarius* (L.) AND METHOPRENE (IGR) ON THE RED FLOUR BEETLE, *Tribolium castaneum* (Herbst.).

By

M.A.Salama* , Helmy A.I.Anber, A. E. Salama* and G. M. Zayed*.**

*Department of Pesticides, Faculty of Agric. Kafr El-Sheikh,
** Department of Plant Protection, Faculty of Agric.
Tanta, University of Tanta , Egypt.

Recived 12/4/1999 – Accepted 25/6/1999.

ABSTRACT

Toxicity of cyanophos was determined by exposure of the adult insects of *S. granarius* to treated wheat grain. The LC_{30}, LC_{50} and LC_{90} values were 8.5, 15 and 150 mg/kg, respectively. The effect of each concentration decreased gradually with the time elapsed and as a result of expanding the exposure time, the mortality percentages increased with each concentration. In general, with the three-exposure intervals tested i.e., 24 , 48 and 72 hr., the effect of the LC_{30} did not continue longer than 40 weeks post-treatment even with the exposure time of 72 hours. The value of LC_{90} persisted more than both LC_{50} and LC_{30} and achieved considerable mortality percentages till 45 weeks post-treatment especially with the exposure time of 48 and 72 hours. So, the longer exposure time of adult insects, the longer persistence of the insecticide.

The results cleared that the exposure to residue of LC_{30} (8.5 ppm) value of cyanophos affected greatly the progeny number of *S. granarius* and the effect of this concentration extended till 45 weeks

post-treatment with percent reduction of the progeny of 58.2%. The residue of LC_{50} (15 mg/kg) value of cyanophos inhibited completely the progeny number till 15 weeks post-treatment, and also the effect was still clearly high till 45 weeks post-treatment, since the percent reduction was 70.4%. While, with the LC_{90} (150 mg/kg) value, the percent reduction was 100% in the progeny number till 40 weeks post-treatment, and also the effect was still clearly high and was closely to 100% reduction till 45 weeks post-treatment.

In general, as the concentration of the insecticide applied increased as the persistence on the grain prolonged or as the reduction in the insect numbers increased. But when the effectiveness of the (IGR) methoprene was evaluated against larvae, pupae and adults of *T. castaneum* with different concentrations. There was no appreciable effect of the (IGR) against the pupae or adults. Sequential effects of this compound on the last instar larvae were followed until adult emergence. Number of dead larvae increased by increasing the concentration of methoprene or the time after treatment and maximum mortality was achieved after 28 days. Most of the alive larvae failed to reach to the pupal stage and still alive for a long period. Less developed pupae were observed especially at higher concentrations. Maximum pupation in larvae was achieved after 10 days post-treatment . Obvious suppressing effect of adult emergence in methoprene treatments (higher inhibition) was obtained at 5 and 10 mg/kg where it was shown as 85.42% and 91.67 % respectively comparing with that in the untreated control.

INTRODUCTION

The effect of grain treatment with different insecticides on the progeny of several insect pests of stored grain was studied by Elek and Longstaff (1994). They assessed the fecundity of *R. dominica, S. oryzae, O. surinamensis* and *T. castaneum* after exposure to wheat treated with 5 benzoylphenyl ureas (BPUs); chlorflurazuron was found to control all 4 species more effectively than triflumuron, teflubenzuron, flufenoxuron or

diflubenzuron. Two weeks of exposure of parents to 0.5 mg/kg of all the BPUs, except diflubenzuron, inhibited almost all F_1 production and all the F_2 production of each species. The fecundities of *T. castaneum* and *O. surinamensis* recovered almost to their untreated levels after 2 weeks exposure to 1 mg/kg of BPUs followed by 2 weeks on untreated wheat, but the effect persisted for at least 2 weeks on untreated wheat in adults of *S. oryzae* and to a lesser extent in *R.. dominica.*

The mean F_1 response of the 4 species after 2 weeks of exposure to 4 doses showed clearly that the 4 newer BPUs were all similar in their overall effectiveness and significantly more effective than diflubenzuron, although diflubenzuron was equally effective against *S. oryzae*. At 0.1 mg/kg, triflumuron was less effective against *O. surinamensis*, while teflubenzuron and flufenoxuron were not very effective against *S. oryzae*. Chlorfluazuron provided the most effective control of all 4 stored product pests, including *S. oryzae*. Eisa and Ammar (1992) investigated various compounds for their residual activity against *S. oryzae* after 2 years in stored wheat grain. Triflumuron, flufenoxuron, teflubenzuron and chlorfluazuron at 1.0 ppm gave good residual control for 1 year; these chemicals at 50 ppm, as well as hexaflumuron, fenoxycarb and Dawco 439, each at 50 ppm, gave complete control for 2 years. Fenoxycarb, alone of 4 juvenoids tested, gave almost complete control at 10 ppm for 18 months. The viability of the wheat was not affected by any of the treatments. Samson *et al.*, (1990), compared the activity of fresh deposits of methoprene, fenoxycarb and diflubenzuron against F_1 progeny of *R. dominica* on maize and rice with that on wheat, at 2 equilibrium relative humidities. There were differences between slopes of (LC-P) lines for different compounds, and for the same compound on different grains, the order of activity against F_1 progeny on different grains was wheat and rice > maize for methoprene; wheat > rice and maize for fenoxycarb; and wheat and maize > rice for diflubenzuron.

Equilibrium relative humidity (e.r.h). had no consistent effect on activity at 90% e.r.h., the LC_{50} of fenoxycarb on wheat was reduced and the LC_{10} of diflubenzuron on maize was increased compared with 70%

e.r.h., and other treatments were unaffected. The efficacy of these compounds on maize and rice against F_1 and F_2 progeny was evaluated during 48 weeks storage at 30.5°C and 70% RH. The resolved S- isomer of methoprene was also induced. Slopes of LC-p lines were greater against the F_2 than against the F_1 generation, particularly using diflubenzuron on rice, with corresponding smaller values of the $LC_{99.9}$. Equally effective concentration did not decline systematically over 48 weeks. Minimum effective application rates were judged as the concentration that prevented living F_2 progeny in at least 2 of 3 replicates. Estimates for 48 weeks protection on maize were methoprene; 2 mg/kg; S-methoprene, 1 mg/kg; fenoxycarb, 10 mg/kg; and diflubenzuron, 5 mg/kg; corresponding estimates on rice were 0.15 mg/kg, 0.05 mg/kg, 5 mg/kg and 5 mg/kg respectivelly .

Chlorfluazuron, a benzoylphenyl urea insecticide, was found to be more potent than diflubenzuron against larvae of the *T. castaneum* (Gazit *et al.*, 1989). Chlorfluazuron was 37 times more toxic than diflubenzuron against 4^{th}-instar larvae but only 4 times more toxic against 1^{st}-instar larvae. While diflubenzuron had no effect on the pupal stage, treatment with chlorfluazuron resulted in a high level of pupa-adult intermediates. Diflubenzuron was detoxified more rapidly than chlorfluazuron in the larvae. Of the total amount of applied to the larvae, 9% of the diflubenzuron could be detected in the pupae compared with 40% of the chlorfluazuron.

No metabolites of chlorfulazuron were detected in either the larvae or pupae, compared with a high level of diflubenzuron metabolites, i.e. 4-chlorophyenyl urea, 4-chloroaniline and polar materials. Simultaneous treatment of insects with diflubenzuron and esterases inhibitors such as phenyl saligenin cyclic phosphate and S, S, S-tributyl phosphorotrithioate resulted in a decreasing of diflubenzuron metabolism and an increase of its retention time in the larval body (T 1/2) to 9 and 18 hrs, respectively. These inhibitors synergized considerably (2-3 times) the larvicidal effect of diflubenzuron, but they did not alter the toxicity of chlorfluazuron. Hence, efficient synergists to

diflubenzuron, based on inhibition of detoxification, might improve its toxicity and help maintain its rapid biodegradable property in the environment.

El-Sayed (1988) reported that wheat flour treated with hydroprene at 5 ppm prevented emergence of adults of *T. granarium* but had a less pronounced effect on adults of *T. confusum*. Hydroprene added to wheat flour increased the number of eggs laid by *T. confusum*, however, high egg and 1st-instar larval mortality was observed in treated food. The growth regulator caused 53.8% mortality of fully-grown larvae of *T. confusum* when applied at 5 ppm to wheat flour. Fully-grown larvae of *T. granarium* were not affected by hydroprene but substantial pupa mortality (65%) was observed. Hydroprene was less active against 1st-instar larvae and caused malformations in larvae and pupae of both species.

Eisa *et al.*, (1986) studied the effect of 2 insect growth regulators chlorfulazuron (IKI-7899) and triflumuron besides, the organophosphorus ovicide isoxathion (Karphos); on the eggs of *T. castaneum* under laboratory conditions. The compounds were added to wheat flour at 0.1, 1.0 and 10 ppm. The results showed that chlorfluazuron was the most effective of the 3 compounds, at concentrations of 1.0 and 10 ppm, no adults of *T. castaneum* emerged, and at 0.1 ppm female reproduction was adversely affected. Triflumuron was also effective in inhibiting adult emergence at the concentrations of 1.0 and 10 ppm although to a lesser extent than chlorfluozuron. Isoxathion at 0.1 ppm stimulated reproduction but inhibited adult emergence only at a concentration of 10 ppm (97.1% inhibition), compared with 7.77% inhibition at a concentration of 0.1 ppm and 30.58 at 1.0 ppm. The addition of these pesticides did not affect wheat flour moisture content. There was a positive correlation between the number of insects and both the fat percentage and the acidity of the wheat flour. But El-Sayed *et al.*, (1984) , recorded that fourteen days-old larvae of *T. confusum* that were fed on flour treated with triflumuron at 0.05 ppm took longer to develop and the number that pupated was smaller than in

untreated flour. The ratio of male to female pupae in flour with triflumuron was 3: 1. Adults of *T. confusum* fed on flour treated with triflumuron at 5 ppm produced more no-viable eggs than those fed on untreated flour.

Concern for the environment has focussed the attention of entomologists on pest control measures that are highly selective. Recently there is great interest in compounds that prevent insect metamorphosis such as insect growth regulators (IGRs). Insect growth regulators as a novel class of insect control agents appear to have a great potential in controlling insects attacking stored grain and grain products. Insect growth regulators have many advantages over conventional insecticides, notably their very low mammalian toxicity and the high specificity. There are two main categories of insect growth regulators (IGRs); juvenile hormone analogues (JHAs) and chitin-synthesis inhibitors such as the benzoylphenyl ureas (Elek and Longstaff, 1994; Oberlander *et al.*, 1997). Juvenile hormone analogues like methoprene and fenoxycarb are very effective for the control of a wide range of stored-product pests. These compounds cause a disruption in insect's normal development leading to lethal morphogenetic effects.

The safety of these compounds, as known at present, makes them desirable candidates for use as postharvest protectants of stored agricultural commodities. Their use against some stored-product insects had been reported by El-Sayed, 1988; Mkhize, 1988; Samson *et al.*, 1990; Gursharan and Singh, 1994; Salama, 1996; Smagghe *et al.*, 1996; Oberlander *et al.*, 1997; Daglish and Pulvirenti, 1998. The red flour beetle, *T. castaneum* (Herbst.), and the granary weevil, *S. granarius* (L.) are two of the major insect pests of stored grain in Egypt.

Therefore, this study was conducted to determine the residual effect of cyanophos on adult of *S. granarius* and effect of insect growth regulator, methoprene against *T. castaneum stages*.

MATERIALS AND METHODS

(a)- Insect strains and wheat

(1)Field strain of *S. granarius*:

Adults of grain weevil, *S. granarius* (L.) were obtained from Kafr El-Sheikh rice and wheat mills companies. The insects were reared on wheat grains, under laboratory conditions of 26 ± 1° C and 65 ± 5% R.H. Adults of 2-3 weeks old were used for toxicity evaluation tests.

(2) Field strain of *T. castaneum*:

Adults of *T. castaneum* were collected from Kafr El-Sheikh rice and wheat mills companies. The insects were reared on a mixture of wheat grains and wheat flour under laboratory conditions of 26 ± 1° C and 65 ± 5% R.H. The media contained also 5% dried yeast.

Adults of 2-3 weeks old were selected for toxicity evaluation tests.

(3)Wheat:

Egyptian whole wheat purchased locally and was sterilised prior to use by heating samples in sealed containers for an hour at 70° C.

(b) Insecticides used:

(1) Cyanophos (50% E.C): o,o-dimethyl-o-(4-cyanophenyl) phosphorothioate.

(2) Methoprene: (1% dust): Isopropyl (2E, 4E)-11-methoxy- 3, 7, 11-trimethyl-2, 4-dodecadienoate.

(C) Persistence of Cyanophos on treated wheat grains and effect on *Sitophilus granarius* progeny:

Series of concentrations of cyanophos were prepared in acetone and applied to clean wheat grain (v/v) to obtain the desired concentrations. The concentrations ranging from 3 to 150 ppm and three replicates per each concentration were used. The log-probit line was drawn. The data of the probit line were analyzed according to (Finney 1971).

Three concentrations were obtained representing LC_{30}, LC_{50} and LC_{90} vlaues from the probit line of cyanophos. The three cocnentrations were prepared in acetone just before application.

Five kilograms of clean wheat grains were treated with LC_{30}, LC_{50} or LC_{90} values. Control samples were sprayed with acetone only. The treated grains were left overnight to permit acetone evaporation. At intervals of zero, 2, 5, 10, 15, 20, 25, 28, 30, 32, 34, 36, 40, 42, 45 weeks post-treamtent, adult insects of the grain weevil, *S. granarius* of 2-3 weeks old were exposed to cyanophos residue on the grain (50 isects/100 gm grain). Every treatment was replicated 3 times at each interval. Mortality percentages were calculated among adults at 24, 48 and 72 hrs after insects exposure to grain containing the residue. The dead insects at each treatment were discarded and the remaining ones were left on the grain. The number of F1 perogeny was counted, then the reduction % was calculated. The jars containing treated or untreated grain were kept in a condition of 26 ± 1oC and 65 ± 5 R.H.

(d) Residual activity of insect growth regulator (Methoprene):

The IGR, methoprene was mixed with wheat grains as dust formulation. Fifty adults, pupae or larvae of field strain of *T. castaneum*, were exposed to the treated medium for 7 days, then transferred to clean media and kept in a condition of 26 ± 1° C and 65 ± 5% R.H. Throughout the test, testing stages were observed after the following intervals; 3, 7, 10, 15, 18, 21, 25 and 28 days. Larvae were inspected for transformation to pupae and then to adults. The mortality percentages of larvae were calculated, the LC_{50} values, the confidence limits and their slopes were calculated according to (Finney 1971).

The criteria used to assess the effectiveness of treatments were based on the reduction in adult emergence and on the number of larvae unable to pupate (permanent larvae). For the determination of the inhibitory effect of methoprene against *T. castaneum* a simple equation was used according to Mulla *et al.* (1975) as follows:-

% inhibition of emergence = 100 -(T/Cx 100) where:

T = Emergence or survival in treatments.
C = Emergence or survival in checks.

Alive larvae, pupae or adults were incubated at the same conditions until the progeny emergence. Experiments at each concentration were replicated three times.

Statistical analysis of the data were carried out according to Difozio (1984).

RESULTS AND DISCUSSION

Log probit line of cyanophos on the wheat grain:

The toxicity of cyanophos was determined by exposure of *S. granarius* adults to treated clean wheat grain. The LC_{50} value on the adult insects was 15 mg/kg whereas the LC_{30} and the LC_{90} were 8.5 and 150 mg/kg, respectively.

Initial and residual effect of cyanophos on the mortality of *S. granarius* adults:

Data recorded in Table (1) indicated the effect of cyanophos on the mortality of *S. granarius* adults through applying three different concentrations, i.e., the LC_{30} value, LC_{50} value and LC_{90} value. The samples were taken after different weeks and adult insects were exposed to treated wheat grain for 24 hours, 48 or 72 hrs. When the exposure time was 24 hrs. at different intervals, results cleared that, generally, the effect of each concentration decreased was gradually with the time elapsed. When the applied concentration was LC_{30} the effect of this concentration ended approximately after 10 weeks post-treatment. Since at the 15 weeks and up, the mortality percentage was only 10% and decreased gradually till 30 weeks post-treatment and no mortality was obtained after 32 weeks of treatment. As for the use of LC_{50} value, the mortality was 28% at 15 weeks of treatment and completely ended at 36 weeks post-treatment. When the LC_{90} value was applied with exposure time of 24 hrs., the results indicated that the effect of this concentration extended

for 45 weeks post-treatment. The mortality percentages were 15%, 12% and 10% at 40, 42 and 45 weeks post-treatment, respectively.

When the treated concentration equal to LC_{30} value, and the exposure time was 48 hrs. after different periods of the treatment, the data indicated that, as a result of expanding the exposure time, the mortality percentages increased with each concentration. The percent of mortality was 46%, 65% and 94% at zero week post-treatment with LC_{30}, LC_{50} and LC_{90}, respectively. Also, the % mortality decreased gradually with the time elapsed post-treatment. Moreover, the increase in the exposure time led to more mortality percentages for long time post-treatment. The same trend was obtained also when the exposure time was 72 hrs. In general, with the three-exposure time tested, the LC_{30} did not continue more than 40 weeks, post-treatment even with exposure time of 72 hrs. The value of LC_{90} achieved considerable mortality percentages till 45 weeks post-treatment especially with exposure time of 48 and 72 hrs. The % mortality was 28% and 60% after exposure time of 48 hrs. and 72 hrs. post-treatment, respectively. With 24 hrs. of exposure time, the effect of LC_{90} value was less than that. These results are again illustrated at the Figs. (1), (2) and (3).

Residual effect of cyanophos on the number of the progeny of *S. granarius* adults:

Data recorded in Table (2) showed the effect of grain treatment with LC_{30}, LC_{50} or LC_{90} of cyanophos on the number of progeny of *S. granarius*. In general, when different concentrations were applied to the grain and the insect adults were exposed for 24 hrs. the results differed from one value to another. The results showed that with LC_{30} value the insect numbers in the progeny were completely reduced directly after the treatment. The effect decreased gradually with the time elapsed. The effect of this concentration was still effective till 45 weeks post-treatment and the percent reduction of the progeny was 58.2%.

With the LC_{50} value the percent reduction in the insect number of the progeny was 100% till 15 weeks post-treatment and also the effect

Table (1):Initial and residual effect of the three tested concentrations , LC_{30}, LC_{50} and LC_{90} values) of cyanophos on the mortality of *S. granarius* adults.

Concentration Ppm	Exposure Time	% Mortality of insects after exposure to residue of the three tested concentrations at indicated weeks post-treatment														
	(hr.)	0	2	5	10	15	20	25	28	30	32	34	36	40	42	45
8.5	24 hr.	30	32	24	16	10	6	4	4	3	0	0	0	0	0	0
15		58	52	50	40	28	10	6	8	10	6	3	0	0	0	0
150		91	85	75	70	60	50	36	30	24	20	21	15	15	12	10
8.5	48 hr.	46	40	35	32	25	20	10	8	10	6	8	4	0	0	0
15		65	70	72	65	45	20	25	20	20	15	20	22	15	7	5
150		94	90	85	85	75	65	40	35	30	32	30	36	30	30	28
8.5	72 hr.	100	95	82	70	65	55	40	28	22	18	12	10	6	0	0
15		100	100	94	90	78	67	40	32	34	28	30	25	20	10	2
150		100	100	100	100	88	90	80	75	69	70	66	70	60	60	60

Table (2):Initial and residual effect of grain treatment with LC_{30}, $LC_{50}$and LC_{90} values of cyanophos on the reduction in the progeny number of *S. granarius* adults at different periods post-treatment.

Conc. Ppm	% progeny reduction after exposure the parental adults to residue of cyanophos at indicated weeks post-treatment														
	0	2	5	10	15	20	25	28	30	32	34	36	40	42	45
8.5	100	99.0	99.2	99.6	97.4	91.6	90.2	87.6	85.8	82.5	80.2	78.6	70.7	65.6	58.2
15	100	100.0	100.0	100.0	100.0	99.2	90.6	90.2	90.8	87.5	85.1	82.5	79.8	72.3	70.4
150	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	94.6

$$\% \text{ Reduction} = \frac{\text{No. of insects in control - No. of insects in treament}}{\text{No. of insects in control}} \times 100$$

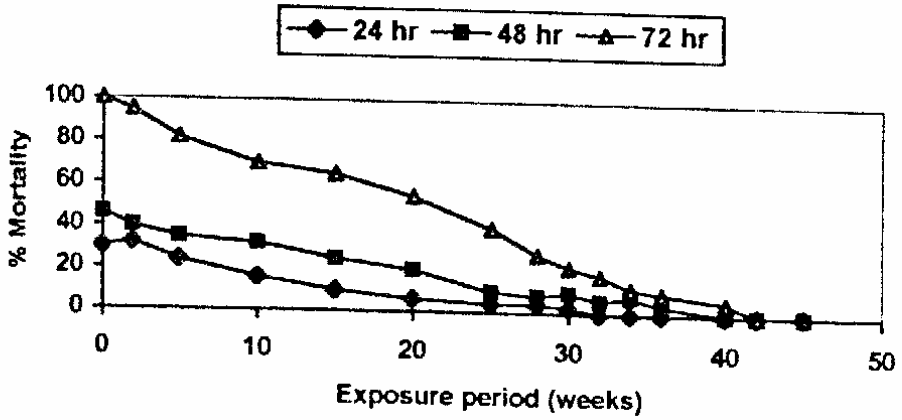

Fig.(1): Relationship between the exposure period of LC_{30} of cyanophos and % mortality of *S. granarius* adults on the wheat grain

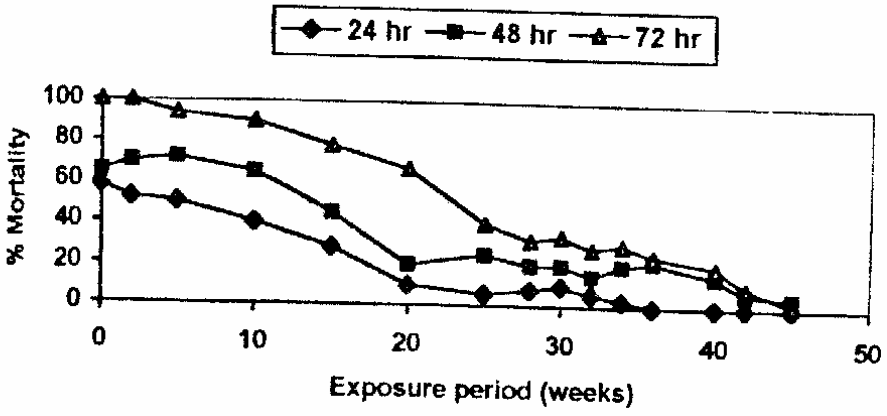

Fig.(2): Relationship between the exposure period of LC_{50} of cyanophos and % mortality of *S. granarius* adults on the wheat grain

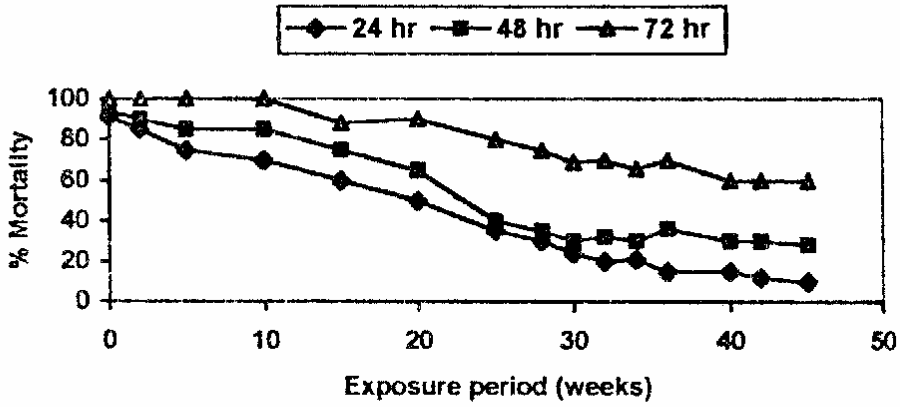

Fig.(3): Relationship between the exposure period of LC_{90} of cyanophos and % mortality of *S. granarius* adults on the wheat grain

was still clearly high till 45 weeks post-treatment since the percent reduction was 70.4%. LC_{90} value of cyanophos achieved 100% reduction in the progeny number till 40 weeks post-treatment and also the effect was still clearly high and was closely near to 100% reduction till 45 weeks post-treatment. In general, as the concentration of the insecticide applied increased as the persistence on the grain prolonged or as the reduction in the insect numbers increased.

As a conclusion depending on data in Tables (1) and (2), a compound like cyanophos with LD_{50} value of 760 mg/kg, which is relatively high, on the albino mice, (Eisa and Bayomy, 1992) had at the same time a good initial and residual effect on *S. granarius* adult insects. It is a good evident to find these advantages in an organophosphates and this may led us to find a good alternative of malathion and also good protectant that may have high potential activity in this respect.

But when methoprene was evaluated against a field strain of *T. castaneum*. Larvae, pupae and adults were exposed to different concentrations that ranged from 0.05-50 mg/kg. There is no appreciable

effect of the JHA, methoprene against the pupae or adults of *T. castaneum*. Sequential effects of treatment of last instar larvae are followed until adult emergence for this compound. The results in Table (3) indicate that larval mortality was independent upon the concentration shortly after treatment (3, 7 or 10 days). While the number of dead larvae increased by increasing the time after treatment and maximum mortality was achieved after 28 days. Most of the larvae failed to reach the pupal stage and were still alive for a long period comparing with the control as shown in Table (3). Some of the larvae reached the next stage (pupal) especially which was treated at low concentrations. Maximum pupation in larvae was achieved after 10 days from the treatment as shown in Table (4). Thirty pupae were developed from 50 larvae in the control. The transformation from larvae into pupae was independent on the concentration. The treatment of wheat grain with methoprene at higher concentrations showed less developed pupae than the control treatment as shown in Table (5). The percent inhibition of adult emergence observed after 28 days from larval treatments is shown in Table (6). The results showed that the high inhibition of adult emergence was obtained at 10 and 50 mg/kg and it was 85.42% and 91.67%, respectively.

As a conclusion, the results indicted that the toxicity of insect growth regulator, methoprene was not-concentration dependent as well as the transformation from larvae into pupae. While the emergence of adults from the initial treated larvae was concentration dependent. Also, it could be concluded that the 24 hrs., 48 hrs. and 72 hrs.. or 7 days mortality counts which are considered as the end points of toxicity for most conventional insecticides to stored grain insects do not apply to insect growth regulators. These findings are in agreement with Georghiou and Lin (1974), which indicated that IGRs activity were mostly assessed as percent inhibition in adult emergence.

There is a complete agreement that insect growth regulators sometimes prolong larval stage by delaying or preventing pupation. The results showed that methoprene affect the larval stage of *T. castaneum* but did not affect pupal and adult stages. Suppressing in the progeny of survival larvae, pupae and adults may be explained on basis of the delayed effect of this compound. El-Sayed (1985) reported that methoprene at 10 ppm substantially reduced emergence of pupae of *T. confusum* and *Trogoderma granarium* and at 0.5 ppm, methoprene

Table (3):Accumulative present larvae of *T. castaneum* within one month observation for pre-exposed larvae* to treated wheat grain with methoprene.

Conc.	No. of present larvae at indicated time (days)															
	3		7		10		15		18		21		25		28	
Mg/kg	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A
0.05	0	50	0	40	0	20	0	18	0	12	3	2	10	1	1	1
0.10	0	50	0	50	0	20	0	20	2	12	5	5	9	3	7	1
0.50	0	50	0	50	0	25	0	21	3	14	9	5	9	5	12	3
1.00	0	43	0	50	0	26	3	25	5	16	6	4	8	4	10	3
5.00	0	45	0	40	1	22	5	18	7	12	7	3	9	1	15	0
10.00	0	46	0	39	0	30	10	14	16	10	16	3	18	3	20	1
50.00	0	46	0	45	1	38	3	15	14	7	12	5	18	3	20	0
Control	0	50	0	48	0	38	1	18	1	10	1	3	1	0	1	0

D = No. of dead larvae A = No. of alive larvae * larvae were exposed.

Table (4): Accumulative present pupae of *T. castaneum* within one month observation for pre-exposed larvae* to treated wheat grain with methoprene.

Conc. (mg/kg)	No. of present pupae at indicated time (days)															
	3		7		10		15		18		21		25		28	
	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A
0.05	0	0	0	0	0	33	0	22	0	10	0	12	0	7	0	7
0.10	0	0	0	0	0	32	0	20	0	18	0	18	0	9	0	10
0.50	0	0	0	0	0	25	0	18	0	13	0	19	1	14	1	12
1.00	0	0	0	12	0	24	0	22	1	17	2	24	2	20	2	20
5.00	0	4	0	10	0	30	1	26	1	26	2	20	3	20	3	16
10.00	0	4	0	10	0	15	0	26	1	28	7	21	7	15	7	12
50.00	0	3	0	3	0	14	0	25	3	27	10	15	9	15	9	10
Control	0	10	0	22	0	30	0	20	0	20	0	7	0	5	0	0

D = No. of dead pupae A = No. of alive pupae * larvae were exposed.

Table (5): Accumulative emergence of adults of *T. castaneum* within one month observation, for pre-exposed larvae to treated wheat grain with methoprene.

Conc. (mg/kg)	No. of present adult at indicated time (days)							
	3	7	10	15	8	21	25	28
0.05	0	0	0	10	15	30	35	36
0.10	0	0	0	8	19	23	27	29
0.50	0	0	0	12	19	20	21	23
1.00	0	0	0	5	10	19	18	20
5.00	0	0	1	4	5	13	14	17
10.00	0	0	1	1	1	4	5	7
50.00	0	0	1	0	1	3	3	4
Control	0	0	5	25	29	38	42	48

* larvae were exposed.

Table (6): Effect of methoprene on the inhibition of adult emergence of *T. castaneum* from pretreated larvae with different concentrations.

Concentrations (mg/kg)	% inhibition of adult emergence
0.05	25.00
0.10	39.58
0.50	52.10
1.00	58.33
5.00	64.58
10.00	85.42
50.00	91.67
Control	-

% inhibition of emergence = 100 - $\left(\frac{T}{C} x100\right)$

inhibited oviposition in the two insects. Methoprene caused morphogenetic malformities in both species and none of the pupal-adult intermediates or malformed adults survived. Cogburn (1988) found that IGRs, fenoxycarb was non toxic to the adult insects but prevent reproduction of *S. oryzae*, *R. dominica* and *T. castaneum*. Also, Smet *et al.*, (1989) found that none of five insect growth regulators tested was effective against parents adults of *T. castaneum*, while all of the compounds except one acted on its progeny. All of the above advantages for methoprene besides its low vertebrate toxicity (LD_{50} = 5,000 mg/kg, oral, rats) indicate that it may has potential as grain protectants for a wide range of stored product insects and during one year storage (Elek and Longstaff, 1994 and Daglish and Pulvirenti, 1998).

REFERENCES

Cogburn, R.R. (1988). Fenoxycarb as a long protectant for stored rough rice. J. Econ. Entomol. 81(2): 722-726.

Daglish, G.J. and C. Pulvirenti (1998). Reduced fecundity of *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) following exposure of adults to methoprene. J. Stored Prod. Res. 34(2/3): 201-206.

Difozio, M.H. (1984). Statistics software for microcomputers kern international. Inc. Duxbury. Massachusetts, U. S. A.

Eisa, A.A. and I.M.A. Ammar (1992). persistence of insect growth regulators against the rice weevil, *Sitophilus oryzae* in grain commodities. Phytoparasitics 20: 1, 7-13.

Eisa, A.A. and M.F. Bayomy (1992). Changes in blood chemistry of albino mice due to induced intoxication with the organophosphorus pesticide cyanophos. J Pest. Control &

Environ. Sci. 4(2): 13-150. Epstein and Legator (1971) Book of Mutagenicity of Pesticide. London p. 120.

Eisa, A.A.; I.M.A. Ammar and A.E.A. El-Sheikh (1986). Effect of two insect growth regulators and the ovicide on the red flour beetle *Tribolium castaneum* when admixed with wheat flour as egg treatment. Entomol. J. Annals Agric. Sci. Moshtohor 24(3):

Elek, J.A. and B.C. Longstaff (1994). Effect of chitin synthesis inhibitors on stored product, beetles. Pestic. Sci., 40: 225-230.

El-Sayed, F.M.A. (1985). Effect of the synthetic insect growth regulator methoprene on larval development and reproduction of two species of stored-product insects. Bull. Soc. Entomol. Egypt. 65, 215-221.

El-Sayed, F.M.A. (1988). Biological activity of the synthetic insect growth regulator "hydroprene" against stored-product coleopterans. Agric. Res. Rev. 66(1): 63-69.

El-Sayed, F.M.A.; M. Abdel-Razik and M.A. Kandil (1984). Biological activity of the insect growth regulator triflumuron against *Tribolium confusum* (Duv.). Bull. Entomol. Soc. Egypt, Econ. Ser., 14, 1984/1985: 171-175.

Finney, D.J. (1971). Probit analysis, 3rd ed. Cambridge University Press. London.

Gazit, Y.; I. Ishaaya and A.S. Perry (1989). Detoxification and synergism of diflubenzuron and chlorflualzuron in the red flour beetle *T. castaneum*. Pestic. Biochem. and physiol. 34(2): 103-110.

Georghiou, G.P. and C.S. Lin (1974). Time-sequence response of *Culex tarsalia* following exposure to insect growth regulators

proceedings and paper of the forty second annual conference of the California Mosquito Control Association. 165-166.

Gursharan and G. Singh (1994). Effect of juvenile hormone and analogues on the reproduction and longevity of rust red flour beetle, *T. castaneum*. J. Insect Sci. 7(1): 91-92.

Mkhize, J.N. (1988). Synthetic juvenile hormone analogues against four species of stored products beetles. Insect. Sci. and its Appl. 9(2): 275-278 [C.F. RAF 1989. 77(2): 145].

Mulla, M.S.; G. Majori and H.A. Dowazed (1975). Effects of the insect growth regulator dimilin or TH-6040 on mosquitoes of some nontarget organisms. Mosquito News. 35: 211-216.

Oberlander, H.; D.L. Silhacek; E. Shaaya and I. Ishaaya (1997). Current status and future perspectives of the use of insect growth regulators for the control of stored product insects. J. Stored Prod. Res. (33): 1: 1-6.

Salama, M.A. (1996). Toxicological and biochemical aspects of benzoylphenyl ureas on resistant and susceptible strains of *T. castaneum* and their side effects on white rats. J. Agric. Sci. Mansoura Univ., 21(4): 1435-1447.

Samson, P.R.; R.J. Parker and Hall E.A. (1990). Efficacy of the insect growth regulators, methoprene, fenoxycarb and diflubenzuron against *Rhizopertha dominica* on maize and paddy rice. J. Stored-Prod. Res., 26: 215-221.

Smagghe, G.; H. Salem; L. Tirryl and D. Degheele (1996). Action of a novel insect growth regulator tebufenozide against different development stages of four stored product insects. Parasitica, 52: 2: 61-69.

.الملخص العربى

دراسة التأثير المتبقى لمبيد السيانوفوس عاى سوسة القمح و منظم النمو (الميثوبرين) على خنفساء الدقيق الحمراء

محمد عبد المحسن سلامة ، حلمى عنبر ، احمد سلامة ، جمال زايد

قسم المبيدات – كلية الزراعة – كفر الشيخ و قسم وقاية النبات – كلية الزراعة – طنطا .

(أ) تم دراسة سمية مبيد السيانوفوس على الحشرات الكاملة من سوسة القمح و كانت قيمة الـ LC_{30} يساوى ٨,٥ جزء فى المليون الـ LC_{50} يساوى ١٥ جزء فى المليون و الـ LC_{90} يساوى ١٥٠ جزء فى المليون ، وتمت معاملة كمية كبيرة من حبوب القمح حوالى ٥ كجم مع كل تركيز من التركيزات الثلاثة حتى تكفى لقياس تأثير المتبقيات من هذا المبيد على سوسة القمح لمدة ٤٥ اسبوع من المعاملة وسحب عينات منها على فترات مختلفه وعند تعريض الحشرات الكاملة لهذه العينات وحساب نسبة الموت لها ثم تسجيل النسبة المئوية للموت فى الحشرات المضافة وكذلك فى الذرية الناتجة عند هذه الفترات من المعاملة وقد اوضحت النتائج الاتى :-

١ – التركيزات الثلاثة اظهرت تأثير فورى بعد المعاملة مباشرة ثم انخفض فاعليتها بمرور الوقت بينما زادت نسبة الموت لهذه التركيزات بزيادة فترة التعريض من ٢٤ساعة الى ٤٨ ساعة ثم الى ٧٢ساعة وقد تلاشى تماما تأثير التركيز الاول LC_{30} بعد مرور ٤٠ اسبوع من التخزين رغم زيادة فترة التعريض الى ٧٢ساعة و تركيز LC_{50} اظهر كفاءة لمدة ٤٠ اسبوع بينما كان التركيز العالى LC_{90} اعلى ثباتا من التركيزين الاول والثانى وكانت نسبة الموت اعلى عند زيادة فترة التعريض الى ٤٨ساعه و ٧٢ ساعه وبالتالى فان زيادة التركيز مع زيادة فترة التعريض تزيد من كفاءة هذا المبيد ضد الحشرات الكاملة لسوسة القمح .

٢ – عند حساب نسبة الانخفاض فى الذرية الناتجة على الحبوب المعاملة بالتركيزات الثلاثة وعلى فترات مختلفه من المعاملة قد اتضح انه بعد مرور خمسة اشهر من المعاملة كانت نسبة الانخفاض تقريبا فى الجيل الناتج مقارنة بالكنترول ٩١,٦% ، ٩٩,٢% ، ١٠٠% على التوالى للتركيزات LC_{30} , LC_{50} ، LC_{90}، اما بعد مرور ٤٥ اسبوع اى ما يقرب من العام كان تأثير المتبقيات من التركيزات الثلاثه السابقة على خفض الناتج من الاجيال بنسبة ٥٨,٢% ، ٧٠,٤% ، ٩٤,٦% على التوالى اى انه يمكن

استخدام التركيز LC_{90} فى حماية الحبوب المخزونه لمدة عام كـــامل دون تعرضـــها للاصابة بالحشرات الكاملة .

(ب) و عند دراسة تاثير منظم النمو الميثوبرين على اليرقات والعذارى والحشرات الكاملـــه لخنفساء الدقيق الحمراء وقد وجد انه لا يوجد تأثير معنوى لـــهذا المركـــب علـــى العـــذارى والحشرات الكاملة كما اظهرت النتائج ان اعداد اليرقات الميته ازدادت بزيادة تركـــيز منظـــم النمو وبزياده فترة التعرض بعد المعاملة وكانت اعلى نسبة موت بعد ٢٨يوم و لقد وجـــد ان عدد كبير من اليرقات قد فشل فى الوصول الى طور العذراء وظلت حية لفترة اطول مقارنتـــا باليرقات غير المعاملة وبعض اليرقات وصلت الى طور العـــذراء خاصتـــا التـــى عوملـــت بالتركيزات المنخفضة . كما كان هناك انخفاض فى اعداد العـــذراء بنســـبة كبـــيرة مقارنـــة بالكنترول خاصتا مع التركيزات العالية وهذا يوضح أن منظم النمو الميثوبرين اظهر كفـــاءة عالية فى اعاقة ظهور الحشرات الكاملة وذلك من واقع الانخفاض فى النسبة المئوية للذريـــة الناتجة حيث كان اعلى نسبة تثبيط فى خروج الحشرة الكاملة عند التركيزين ٥ ، ١٠ ميلجرام / كجم من الدقيق وكانت نسبة التثبيط لهما هى ٨٥,٤٢% ، ٩١,٦٧ % على الـــترتيب ممـــا يوضح تأثير هذا المركب فى خفض الناتج من ذرية الحشرات المعاملة وذلـــك عـــن طريـــق التأثير المعنوى على الطور اليرقى منها .