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MOLLUSCICIDAL ACTIVITY OF SIX PESTICIDES AGAINST THE TWO LAND SNAILS, *Monacha cantiana* AND *Eobania vermiculata* (GASTROPODA: Helicidae) UNDER LABORATORY CONDITIONS.

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ABSTRACT

The following six pesticides namely, bensultap, chlorpyrifos-ethyl, deltamethrin, diazonixy, lambda-cyhalothrin and methomyl were laboratory tested for their molluscicidal activity against the two land snails, *Monacha cantiana* (Montagu) and *Eobania vermiculata* (Muller) as poisonous baits at a constant concentration of 2%. Results revealed the toxic effect of all tested pesticide baits with mortality percentage increasing with an increase in the period of exposure. It was evident that deltamethrin belonging to pyrethroid group exceeded other pesticides and showed high initial toxicity of 70.0% and 93.3% against *M. cantiana* and *E. vermiculata,* respectively after three days of exposure. However, methomyl belonging to carbamate group surpassed other pesticides and gave 100.0% mortality after seven and 12 days for the two land snails, *M. cantiana* and *E. vermiculata,* respectively. On the other hand, chlorpyrifos-ethyl exhibited the lowest mortality percentages against the tested land snails. Obviously, methomyl proved to be the most effective pesticides followed by deltamethrin, bensultap, lambda-cyhalothrin, diazonixy then chlorpyrifos-ethyl against the two land snails. Moreover, the brown garden snail, *E. vermiculata* showed more sensitivity to the tested pesticides especially methomyl and deltamethrin than the clover snail, *M. cantiana.*

Keywords: land snails, *Monacha cantiana, Eobania vermiculata,* pesticides, mortality percentage.

INTRODUCTION

Land snails (Mollusca: Gastropoda) are serious and widespread pests in nurseries, greenhouses, orchards and field crops in many parts of the world. In Egypt, the two land snails, *Monacha cantiana* (Montagu) and *Eobania vermiculata* (Muller) became the most important agricultural pests causing substantial damage to different crops in North Coast, new reclaimed lands and all over the Nile Delta (El- Deeb *et al.*, 1999, Mahrous *et al.*, 2002 and Khidr *et al.*, 2005).

Control of snails or slugs on different crops is heavily dependent on the use of pesticides that limit the effect of these pests below damaging level. Hence, the synthetic molluscicides or pesticides are the most effective measures available at present for the control of terrestrial gastropods (El-Wakil and Radwan, 1991; Hanafy *et al.*, 1998; Hussein *et al.*, 1999; El-Khodary *et al.,* 2001; Heiba, *et al.*, 2002; Genena, 2003; Abd-El-All, 2004; Ismail *et al.*, 2005 and Zedan *et al.* 2006). However, some of these pesticides

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are environmentally very stable, which meant that the risk of accumulation is very high, and as a result, permission to use them as pesticides has been restricted (Ohayo *et al.*, 1997). Thus we are in need for new and safe pesticides or molluscicides with different mode of action.

Therefore, the present study was conducted to evaluate the effect of six pesticides applied as baits against the two land snails, *M. cantiana* and *E. vermiculata* under laboratory conditions at 20ºC**±** 2ºC and 60%± 5% R.H.

MATERIALS AND METHODS

Six pesticides belonging to four different chemical groups were used as baits at a constant concentration (2% a. i.) to evaluate their efficacies against the two land snails, *M. cantiana* and *E. vermiculata* under laboratory conditions. the Common name, trade name, chemical group and chemical structure are shown in table (1).

1. Tested snails:

Adult snails of *M. cantiana* and *E. vermiculata* were collected from infested nurseries and field crops in Experimental farm of Mansoura University, Mansoura, Dakahlia Governorate. The obtained snails were transferred in plastic bags to the laboratory, then kept in plastic containers filled with moist sterilized sandy loamy soil 1:1 (v:v) and fed on fresh leaves of lettuce (*Lactuca sativa* L.) for 14 days to be laboratory acclimatized.

2. Baits preparation:

Pesticide baits were prepared according to the method suggested by Hanafy *et al.* (1998). Accordingly, a constant concentration (2% a.i.) of the tested pesticides was dissolved in a mixture containing 10 ml of equal volumes of acetone and ethanol in addition to the methylene blue 0.5% as attractant material. After that, each of the pesticide was carefully mixed with a suitable amount of bran in a plastic jar, and then spread on a plastic sheet until it became rather dry. Control treatment was prepared using bran bait only without any pesticides.

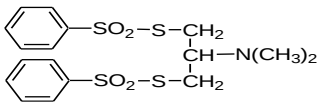
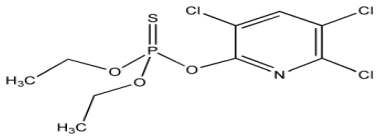
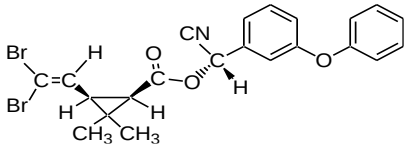
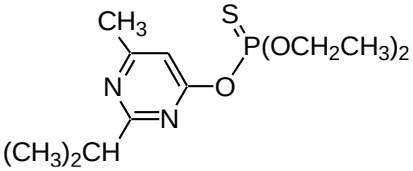
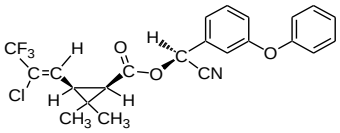
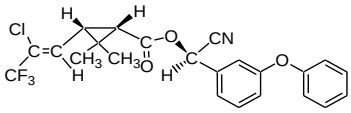
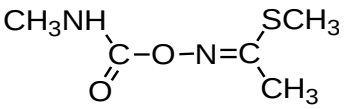
3. Experimental design:

The experiment took place under laboratory condition at 20ºC± 2ºC and 60%± 5% R.H. For each land snail species ten grams of each pesticide bait were transferred to plastic cups 12 cm-diameter (250 gm capacity) filled with 100 gm moist sterilized sandy soil: loamy soil 1:1 (v:v). Ten adult snail individuals with approximately similar size were then transferred from stock culture to plastic cups. Each cup was then covered with muslin cloth held by rubber bands. Each of the above mentioned pesticides and the control were replicated three times. The tested snails were examined daily and for 12 days, where the dead individuals were counted and removed. Mortality percentages were recorded one, three, five, seven, ten and 12 days post treatment.

Data analysis:

Data were subjected to analysis of variance (ANOVA) (Gomez and Gomez, 1984) followed by Duncan's multiple range tests to compare means (Duncan, 1955).

Table (1): The tested pesticides and their common name, trade name, chemical group and chemical structure:

Common name	Trade name	Chemical group	Chemical structure
Bensultap	Bankol (50% W.P.)	Bensultap	
Chlorpyrifos-ethyl	Chlorozan (48% E.C.)	Organophosphate	
Deltamethrin	Kothrine (5% E.C.)	Pyrethroid	
Diazonixy	Diazinon (60% E.C.)	Organophosphate	
Lambda-cyhalothrin	Plumic (32.5% E.C.)	Pyrethroid	(*S*) (*Z*)-(1*R*)-*cis*-  +  (*R*) (*Z*)-(1*S*)-*cis*-
Methomyl	Lannate (90% W.P.)	Carbamate	

RESULTS AND DISCUSSION

1-Efficacy of six pesticides applied as toxic baits against the clover snail, *M. cantiana*, under laboratory conditions:

The mortality percentage of the clover snail, *M. cantiana* after certain periods of exposure to six pesticides applied as toxic baits, are represented in table (2). Results indicated that all tested pesticides were found to be toxic against *M. cantiana* with various extent. A positive correlation has noticed between mortality percentage of tested snails and exposure time to tested pesticides.

It was evident that after one day of exposure to poisonous baits, diazonixy and lambda-cyhalothrin as well showed no lethal effect against the land snail, *M. cantiana.* However, methomyl and bensultap as well as chlorpyrifos-ethyl had low initial effect with mortality percentages of 6.6%, 3.3% and 3.3%, respectively. Conversely, deltamethrin belonging to pyrethroid group exhibited 50% mortality of the land snail *M. cantiana*. All tested pesticides showed gradually increase in the cumulative mortality percentage after five days of exposure and till the end of experiment. It is worthy to note that no dead snails were found in the untreated cups (CK) during the run of experiment.

Generally it can be noticed that 12 days after treatment methomyl was the highest toxic compound against the clover land snail, *M. cantiana* with mortality percentage of 100%, whereas chlorpyrifos-ethyl was the lowest one (13.3%). The tested pesticides can be arranged in descending order according to its mortality percentages as follows: methomyl> deltamethrin> bensultap> lambda-cyhalothrin> diazonixy> chlorpyrifos-ethyl.

Table (2): Mortality percentages of the clover snail, *M. cantiana* after certain periods of exposure to six pesticide baits.

Days after treatment	Mortality %:					
	Methomyl	Deltamethrin	Bensultap	Lambda	Diazonixy	Chlorpyrifos-ethyl
1	6.6 lm	50.0 fg	3.3 lm	0.0 m	0.0 m	3.3 lm
3	33.3 ghi	70.0 de	6.6 lm	0.0 m	13.3 jklm	3.3 lm
5	56.6 ef	86.6 abcd	13.3 jklm	6.6 lm	13.3 jklm	3.3 lm
7	76.6 cd	90.0 abc	26.6 hijk	10.0 klm	13.3 jklm	10.0 jklm
10	96.0 ab	93.0 abc	50.0 fg	20.0 ijkl	16.6 ijklm	13.3 jklm
12	100.0 a	93.0 abc	50.0 fg	40.0 fgh	16.6 ijklm	13.3 jklm

Each number presented the mean of three replicates

Mean of mortality percentages followed by the same letter(s) are not significantly different at 0.05 level, according to Duncan's multiple range test (Duncan, 1955).

2- Efficacy of six pesticides applied as toxic baits against the brown land snail, *E. vermiculata*, under laboratory conditions:

The molluscicidal activity of six pesticides applied as toxic baits against the brown garden snail, *E. vermiculata* is shown in table (3). Data indicated the toxic effect of all tested pesticide baits with mortality percentage increasing with an increase in the period of exposure. From table (3) it was

evident that the tested pesticides bensultap, lambda-cyhalothrin, diazonixy and chlorpyrifos-ethyl showed no lethal effect against the land snail, *E. vermiculata* two days after exposure. However, methomyl showed low initial effect with mortality percentage 6.7%. Conversely deltamethrin belonging to pyrethroid group exhibited 46.6% mortality of the brown land snail, *E. vermiculata.*

After three days, mortality percentage increased gradually for methomyl, deltamethrin, bensultap and lambda-cyhalothrin, while diazonixy and chlorpyrifos-ethyl still showed no lethal effect. Deltamethrin significantly overwhelmed other pesticides and showed 93.3% after three days of exposure. However, as the time elapsed to the fifth day all tested pesticides except chlorpyrifos-ethyl showed gradually increase in the cumulative mortality percentage and methomyl surpassed all other pesticides and exhibited the highest mortality percentage (100%) against *E. vermiculata* after seven days of exposure. Herein no dead snails were found in the untreated cups (CK) during the run of experiment. The tested pesticides can be arranged descending according to its mortality percentages as follows: methomyl> deltamethrin> bensultap> lambda-cyhalothrin> diazonixy> chlorpyrifos-ethyl.

Table(3): Mortality percentages of the brown garden snail, *E. vermiculata* after certain periods of exposure to six pesticide baits.

Days after treatment	Mortality %:					
	Methomyl	Deltamethrin	Bensultap	Lambda	Diazonixy	Chlorpyrifos - ethyl
1	6.7 i	46.6 cde	0.0 i	0.0 i	0.0 i	0.0 I
3	40.0 def	93.0 a	13.3 ghi	6.6 hi	0.0 i	0.0 i
5	86.6 ab	93.0 a	26.6 efgh	20.0 fghi	6.6 hi	0.0 i
7	100.0 a	93.0 a	26.6 efgh	20.0 fghi	20.0 fghi	3.3 hi
10	100.0 a	93.0 a	46.6 cde	33.3 defg	20.0 fghi	13.3 ghi
12	100.0 a	93.0 a	53.3 bc	40.0 def	26.6 efgh	20.0 fghi

Each number presented the mean of three replicates
Mean mortality percentages followed by the same letter(s) are not significantly different at 0.05 level, according to Duncan's multiple range test (Duncan, 1955).

The brown garden snail, *E. vermiculata* showed more sensitivity to tested pesticides compared to clover snail, *M. cantiana,* while the toxic compound, lambda-cyhalothrin gave the same percentage mortality against the two land snails with values of 40.0% after 12 days of treatment (Fig1). Methomyl performed the highest percentage mortality against the two land snails, *E. vermiculata* and *M. cantiana* with value of 100.0% after seven and 12 days of exposure, respectively, while chlorpyrifos-ethyl gave the lowest one with values of 20.0% and 13.3% after 12 days of treatment, respectively (table 3& Fig1).

Cholinesterase- inhibitor organophosphorous compounds (e.g. diazonixy, chlorpyriphos) have become used since 1936 for the control of insect pests. They cause over excitation in the insect nervous system (Pope, 1999), that eventually leads to death. These compounds are however, highly

toxic for other species, too (Ohayo, *et al.*, 1997; Blaquiere *et al.*, 2000 and Dam *et al.*, 2000). In our study these compounds showed low to moderate toxicity against the two land snails, *M. cantiana* and *E. vermiculata* with mortality of 16.6% & 13.3% and 26.0% & 20.0%, respectively in comparison with other pesticides. These results agree with the findings of Ismail *et al.*, 2005 in respect to chlorpyriphos, they reported that chlorpyrifos was the lowest effective pesticide against the land snail, *M. cantiana* when compared with *E. vermiculata* under laboratory conditions.

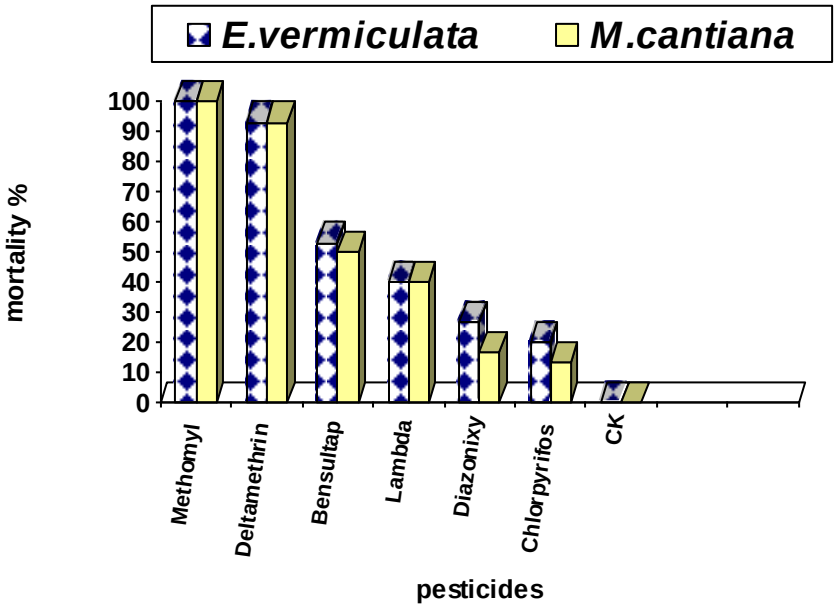


Fig. (1): Mortality percentages of the two land snails, *M. cantiana* and *E. vermiculata* exposed to six pesticides applied as baits after 12 days of treatment.

Nicotinic acid (a toxin of *Nicotinia tabacum*) and its derivates were introduced generally as effective pesticides. Nicotinic acid acts an agonist at nicotinic acetylcholine (ACh) receptors and also causes excessive excitation in insects. Recently derivatives of nicotinic acid have been widely used to control different pests. These compounds decompose more readily and show larger specificity for insect transmitter receptors than the above mentioned pesticides. They influence the intensity of the sodium current through the ligand-gated cholinergic receptor (Matsuda *et al.*, 2001).

Bensultap a nereistoxin analogue was introduced in 1993. It is used against the Colorado beetle and some other insect pests (Civelek and Weintraub, 2003). Herein, bensultap showed promising results and exhibited 50.0% and 53.0% mortality against *M. cantiana* and *E. vermiculata*, respectively. Although bensultap has low toxicity in mammals, (Gyori *et al.*, 2007) reported that bensultap altered the synaptic transmission in rat as well

as the terrestrial snail, *Helix pomatia* central nervous system. Bensultap caused a significant decrease of ACh- induced current.

Pyrethroids (e.g. deltamethrin & lambda-cyhalothrin) are synthetic versions of pyrethrins, specifically designed to be more stable in the environment and thus provide longer-lasting control. They act on tiny channels through which sodium is pumped to cause excitation of neurons. They prevent the sodium channels from closing, resulting in continual nerve impulse transmission, tremors, and eventually, death (Brown, 2006).

In the present study, deltamethrin overwhelmed lambda-cyhalothrin and other tested pesticides and showed highly initial toxic effect against *M. cantiana* and *E. vermiculata* with mortality of 70.0% and 93.0%, respectively after three days of treatment.

Carbamate insecticides are known as cholinesterase inhibitors. They cause over stimulation of the nervous system, and the insect dies (Brown, 2006). Methomyl showed molluscicidal activity against *M. cantiana* and *E. vermiculata* with mortality of 76.0% and 100.0%, respectively after seven days of treatment. For the two land snails, and after 12 days of treatment methomyl performed the best pesticide used followed by deltamethrin. These results are in accordance with those reported by El- Wakil and Radwan, (1991); Hanafy *et al.*, 1998; Genena, (2003) and Rabeih *et al.*,(2005).

Moreover, the brown garden snail, *E. vermiculata* was more sensitive to the tested pesticides, deltamethrin and methomyl than the clover snail, *M. cantiana*. These results support the findings of Heiba *et al.*(2002) in respect to methomyl.

In conclusion, additional research is needed to evaluate the molluscicides of the tested pesticides against the economic terrestrial snails under field conditions.

REFERENCES

Abd- El All, S.M. (2004): Toxicity and biochemical response of *Eobania vermiculata* land snail to niclosamide molluscicide under laboratory and field conditions. J. Agric. Sci. Mansoura Univ., 29 (8): 4751-4756.

Blaquiere, d.G.E.; Waters, L.; Blain, P.G. and Williams, F.M. (2000): Electrophysiological and biochemical effects of single and multiple doses of the organophosphate diazinon in the mouse. Toxicology and Applied Pharmacology, 166: 81–91.

Brown, A.E. (2006): Mode of action of structure pest control chemicals. Pesticide Information Leaflet, 41: 1-8.

Civelek, H.S. and Weintraub, P.G. (2003) :Effects of bensultap on larval serpentine leaf miners, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae), in tomatoes. Crop Protection, 22: 479–483

Dam, K.; Seidler, F.J. and Slotkin, T.A. (2000): Chlorpyrifos exposure during a critical neonatal period elicits gender-selective deficits in the development of coordination skills and locomotors activity. Developmental Brain Research, 121: 179–187.

Duncan, D.B. (1955): Multiple range and multiple F-test. Biometrics, 11:1-42.

El- Deeb, H.I.; Zedan, H.Z.; Abd El-Aal, S.M. and Mohamed, H.L. (1999): Toxicity and biochemical studies on the terrestrial snails, *Monacha cantiana* treated with some natural products and pesticides. 2nd Int. Conf. of Pest Control, Mansoura, Egypt, Sept., 1:1-12.

El- Khodary, A. S.; Sharshir, F. A.; Helal, R. M. and Shahawy, Wafaa A. (2001): Evaluation of some control methods against the land snail, *Monacha cantiana* (Montagu) at Kafr El- Sheikh Governorate, Egypt. J. Agric. Res. Tanta Univ., 27 (2): 290- 300.

El-Wakil, H. B. and Radwan, M. A. (1991): Biochemical studies on the terrestrial snail, *Eobania vermiculata* (Muller) treated with some pesticides. J. Environ. Sci. and Health, 26 (596): 479-489.

Genena, Marwa A.M. (2003): Studies on the terrestrial gastropods at Dakahlia Governorate. M.Sc. Thesis, Fac. Agric., Mansoura Univ. 136 pp.

Gomez, K. A. and Gomez, A.A. (1984): Statistical procedures for Agricultural Research. 2th Ed., John Wily& Sons: INC., New York.

Gyori, J.; Varro, P.; Zielinska, E.; Banczerowski, I. and Vilagi, I. (2007): Bensultap decreases neuronal excitability in molluscan and mammalian central nervous system. Toxicology in Vitro 21: 1050–1057.

Hanafy, A.H.A.; Youssef, H.M. and El- Shahat, M.S. (1998): Preparation of methomyl baits and efficacy against certain land Mollusca in different vegetation. Adv. Agric. Res., 3 (3): 435-441.

Heiba, F.N.; Al-Sharkawy, M. I. and Al-Betal, A.A.(2002): Effect of the insecticide, lannate, on the land snails, *Eobania vermiculata* and *Monacha cantiana*, under laboratory conditions. J. Biological Sci., 2 (1): 8- 13.

Hussein, H.i.; Al- Rajhy, D.; El- Shahawi, F.I. and Hashem, S.M. (1999): Molluscicidal activity of *Pergularia tomentosa* (L.), methomyl and methiocarb against land snails. International J. of Pest Management, 45 (3): 211-213.

Ismail, S. A.; Abd- Allah, S. A.; El- Massry, S. A. and Hegab, A. M.(2005): Evaluation of certain chemicals and insecticides against *Monacha cartusiana* snails infesting some vegetable crops at Sharkia, Governorate. J. Agric. Sci. Mansoura Univ., 30 (10): 6283-6292.

Khidr, F.K; Gabr, W.M.; Youssef, A.S. and Hussien, S.S. (2005): Biochemical effects of two natural pesticides on the brown garden snail, *Eobania vermiculata.* Egypt. J. Agric. Res.,(in press).

Mahrous, M.E; Ibrahim, M.H. and Abdel-Aal, E.M. (2002): Occurrence, population density and importance value of land snails infesting different crops in Sharkia Governorate, Egypt. Zagazg J. Agric. Res., 29 (2): 613-629.

Matsuda, K.; Buckingham, S.D.; Kleier, D.; Rauh, J.J.; Grauso, M. and Sattelle, D.B., (2001): Neonicotinoids: Insecticides acting on insect nicotinic acetylcholine receptors. Trends in Pharmacological Sciences, 22: 573–580.

Ohayo, G.J.A.; Heederik, D.J.J.; Kromhout, H.; Omondi, B.E.O. and Boleij, J.S.M. (1997): Acetylcholinesterase inhibition as an indicator of organophosphate and carbamate poisoning in Kenyan agricultural workers. International Journal of Occupational and Environmental Health, 3: 210–220.

Pope, C.N. (1999): Organophosphorus pesticides: Do they all have the same mechanism of toxicity? Journal of Toxicology Environmental Health, 2: 161–181.

Rabeih, K. A.; Abdel Halim, K. Y. and Hussien, A. A. (2005): Molluscicidal efficiency of some pesticides against *Helix aspersa* land snails under laboratory conditions. J. Agric. Sci. Mansoura Univ., 30 (2): 1129-1134

Zedan, H. A.; Mortada, M. M. and Shoeib, Amera A. (2006): Assessment of molluscicidal activity of certain pesticides against two land snails under laboratory and field circumstances at Dakahlia Governorate. J. Agric. Sci. Mansoura Univ., 31 (6): 3957-3962.

تقييم فعالية ستة أنواع من المبيدات فى مكافحة نوعين من القواقع الأرضية هما قوقع البرسيم ***Monacha cantiana*** وقوقع الحدائق البنى ***Eobania vermiculata*** تحت الظروف المعملية.

مروة عزمى مختار جنينة و فاطمة عبد المحسن مصطفى

قسم الحيوان الزراعى – كلية الزراعة – جامعة المنصورة ٠

تم اختبار فعالية ستة أنواع من المبيدات الكيمائية وهى الميثوميل، دلتاميثرين، البانزولتاب، لمبادا، ديازينوكسى وكلوروبيروفوس ايثل ضد نوعين من القواقع الأرضية *M. cantiana* و *E. vermiculata* فى صورة طعوم سامة وبتركيز ثابت (٢% مادة فعالة) ولمدة اثنتا عشر يوما وذلك تحت الظروف المعملية.

وأظهرت النتائج ما يلى:-

1- كان مبيد الميثوميل اكثر المبيدات المختبرة فعالية ضد نوعى القواقع المختبرة ، حيث أعطى أعلى نسبة موت وهى ١٠٠% بعد سبعة أيام من المعاملة للقوقع *E. vermiculata* وبعد ١١ يوم من المعاملة للقوقع *M. cantiana*

2- تراوحت نسبة الموت ما بين ١٣,٣% إلى ١٠٠% عند استخدام الستة مبيدات ضد قوقع البرسيم *M. cantiana* بينما تراوحت ما بين ٢٠% إلى ١٠٠% عند استخدام الستة مبيدات السابقة ضد قوقع الحدائق البني *E. vermiculata* وذلك بعد اثنا عشر يوما من المعاملة.

3- اظهر مبيد الكلوروبيروفوس ايثل اقل نسبة موت حيث وصلت إلى ١٣,٣% و٢٠% ضد القوقعين *M. cantiana* و *E. vermiculata* على التوالي، وذلك فى نهاية مدة التجربة.

4- بزيادة مدة التعريض للطعم السام تزداد نسب الموت.

5- كان قوقع الجدائق البنى *E. vermiculata* اكثر حساسية ضد المبيدات المختبرة مقارنة بقوقع البرسيم *M. cantiana* بينما تساوت نسبة الموت عند استخدام المبيد (لمبادا), حيث بلغت نسبة الموت ٤٠% بعد ١٢ يوم من المعاملة.