target terrestrial snail, *Eobania vermiculata*. *Alex. Sci. Exch.* 12 (2): 129-139.

14- **Radwan, M.A., El-Wakil, H.B. and Osman, K.A. (1992).** Toxicity and biochemical impact of certain oxime carbamate pesticides against terrestrial snail, *Theba pisana* (Müller). *J. Environ. Sci. Health*. B, 27: 759 – 773.

15- **Radwan, M.A., El-Gendy, K.S. and Gad, A.F. (2010).** Biomarkers of oxidative stress in the land snail, *Theba pisana* for assessing ecotoxicological effects of urban metal pollution. *Chemosphere* 79, 40–46.

16- **Radwan, M.A., Essawy, A.E., Abdelmeguied, N.E., Hamed, S.S. and Ahmed, A.E. (2008).** Biochemical and histochemical studies on the digestive gland of *Eobania vermiculata* snails treated with carbamate pesticides. *Pesticide Biochem. Physiol*. 90, 154–167.

17- **Simms, L.C., Ester, A. and Wilson, M. J. (2006).** Control of slug damage to oilseed rape and wheat with imidacloprid seed dressings in laboratory and field experiments. *Crop Prot.* 25, 549 –555.

18- **Smith, G., Hardy, A.R., Brown, P.M., Fletcher, M.R., Stanely, P.I., Westlake, G.E, and Lloyd, G.A. (1988).** *Assessment of the hazard to wildlife from the use of methiocarb to protect ripening cherries*. ADAS Tolworth Lab., hook Ries South, Surbtion KT67NF,United Kingdom

19- **Tomizawa, M. and Casida, J.E. (2005).** Neonicotinoid insecticide toxicology: mechanisms of selective action. *Annu. Rev. Pharmacol. Toxicol.* 45, 247–268.

20- **World Health Organization (1963).** Molluscicidal screening and evaluation. W.H.O Bull., 38, 507-581.

21- **Zavattari, E. (1934).** Funa Della Libia. VII- Molluscs (Gastropoda) in Libia. Pp. 108-127.

4- **Duncan, J. and Sturrock, R.F. (1983).** Laboratory evaluation of potential plant molluscicides In Kenneth, E.M. (eds.). Plant Molluscicides. Jon Wiley and Sons LTD, pp. 251-265.

5- **El-Sebae, A.H., El-Okda, M.M.K. and Marei, A.S. (1982).** Local formulation of three carbamoylated oximes as terrestrial molluscicides, *Agric. Res. Rev.* 60, 85– 91.

6- **Finney, D. J. (1971).** Probit analysis, Cambridge University Press, London 3rd Ed., p.318

7- **Genena, M.A.M. and Mostafa, F.A.M. (2008).** Molluscicidal activity of six pesticides against the two land snails, *Monacha cantiana* and *Eobania vermiculata* (Gastropoda: Helicidae) under laboratory conditions. *J. Agric. Sci. Mansoura Univ.,* 33 (7): 5307-5315.

8- **Godan, D. (1983).** Pest Slugs and Snails, Biology and Control, Springer-Verlage, Berlin Pp. 445.

9- **Heiba, F.N., Al-Sharkawy, I.M. and Al-Batal, A.A. (2002).** Effects of the insecticide Lannate, on the land snail, *Eobania vermiculata* and *Monacha contiana*, under laboratory conditions. *Online J. Biol. Sci.* 2, 8–13.

10- **Homeida, A.M. and Cooke, R.G. (1982).** Pharmaological aspects of metaldehyde poisoning in mice. *J. Vet Pharmacol. Ther.,* 5: 77-82

11- **Madejón, P., Arrébola, J., Madejón, E., Burgos, P., López-Garrido, R., Cárcaba, A., Cabrera, F. and Murillo, J.M. (2013).** The snail *Theba pisana* as an indicator of soil contamination by trace elements: potential exposure for animals and humans. *Journal of the Science of Food and Agriculture* 93, 2259–2266.

12- **Radwan, M.A. (1993).** A technique for testing the efficacy of molluscicidal baits against land snails. *Com. Sci. Dev. Res.,* 651: 17-26.

13- **Radwan, M.A. and El-Wakil, H.B. (1991).** Impact of certain carbamate and synthetic pyrethroid insecticides on the non-

مقارنة التأثيرات السامة لبعض المبيدات الحشرية ضد القوقع الأرضي *Theba pisana*

مريم صالح محمد و محمد رضوان

قسم الوقاية كلية الزراعة جامعة عمر المختار، البيضاء ليبيا

الملخص

تم دراسة مقارنة التأثيرات السامة لواحد من البيروثيرودات الصناعية (سايبرميثرين)، واحد من مجموعة النيونيكوتينويد (إميداكلوبريد) وواحد من الكاربامات (ميثوميل) كطعوم سامة ضد القوقع الأرضي *Theba pisana* تحت الظروف المعملية. وتم تسجيل النسبة المئوية للموت حتى أربعة أيام وحساب قيم LC_{50} ، LT_{50} للمبيدات المختبرة . أظهرت النتائج أن قيم المتوسط اليومي للنسبة المئوية لموت القواقع تتراوح من 19.16 – 60 % ، 15–48.33 % و 22.5–70 % للسيبرميثرين ، الايميداكلوبريد و الميثوميل علي الترتيب ، وأن كفاءة الطعوم المختبرة تعتمد علي كل من التركيز و الوقت. وكان الميثوميل أكثر المبيدات المختبرة سمية ضد القوقع الأرضي يليه السيبرمثرين ثم الايميداكلوبريد حيث كانت قيم LT_{50} 2.58 ، 4.21 و 5% علي التوالي .

References

1- **Bailey, S. E. R. (2002).** Molluscicidal baits for control of terrestrial gastropods. In: Barker, G.M.(Ed.), Molluscs as Crop Pests. CABI Publishing, Wallingford, pp. 33 –54.

2- **Baker, G.H., Beckett, S. and Thammavongsa, B. (2012).** Are the European snails, *Theba pisana* (Müller, 1774) (Helicidae), *Cernuella virgata* (da Costa, 1778) and *Cochlicella acuta* (Müller, 1774) (Hygromiidae) attracted by potential food odours?. *Crop Prot.* 42, 88-93.

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

Pyrethroids (e.g. cypermethrin) 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). Cypermethrin is designed to kill insects. It can also be promising as poison baits against the terrestrial snail, *Theba pisana* in the present study. This is in agreement with Radwan and El-Wakil (13) who reported that cypermethrin- treated lettuce discs exhibited high mortality percentages among other synthetic pyrethroids against *Eobania vermiculata* snails. Moreover, *E. vermiculata* snails were more affected by 2% toxic baits of deltamethrin as a cyano- pyrethroids like cypermethrin (7).

Imidacloprid was generally introduced as effective insecticide for controlling different pests. It acts an agonist at nicotinic acetylcholine receptors (nAChR) and also causes excessive excitation in insects. This compound decompose more readily and show larger specificity for insect transmitter receptors. It is also influence the intensity of the sodium current through the ligand-gated cholinergic receptor (19). The data obtained in our study are in agreement with the study of Semis *et al.* (17) who indicated that imidacloprid was found to have little activity against slugs and this insecticide significantly reduced the slug damage in oil seed rape and wheat fields when used at high doses.

Further research is needed to evaluate the molluscicidal activity of the tested insecticides against *T. pisana* snails under field conditions.

Table 2. Toxicity parameters of some insecticides to *Theba pisana* snails fed on treated baits.

Insecticide	Exposure time (day)	LC_{50} (%)	Fiducial limits of LC_{50}		Slope	SE	Qui square (χ^2)	LT_{50}* (days)
			Upper	Lower				
Cypermethrin	1	3.64	4.10	2.63	0.73	0.25	3.87	4.21
	2	1.14	2.71	0.48	0.87	0.23	0.16	
	3	0.38	0.56	0.25	1.14	0.23	2.09	
	4	0.16	0.24	0.11	1.15	0.23	1.68	
Imidacloprid	1	3.30	4.16	0.50	0.86	0.26	0.21	5.00
	2	2.90	3.20	0.72	0.66	0.24	0.70	
	3	1.14	2.70	0.48	0.87	0.23	0.16	
	4	0.28	0.44	0.18	0.92	0.22	0.99	
Methomyl	1	-	-	-	-	-	-	2.58
	2	0.36	0.44	0.29	1.03	0.23	1.68	
	3	0.21	0.29	0.15	1.33	0.23	2.85	
	4	0.08	0.13	0.04	1.20	0.32	1.16	

*LT_{50} values were calculated based on the average percent mortality of different concentrations at each exposure time.

LC_{50} values for each compound were decreased with the increase of exposure time. This indicates that methomyl was the most toxic compound followed by cypermethrin and imidacloprid against the snail under investigation (Table 2). In order to evaluate the prolonged varied mortality percentages of the snails treated with different pesticides, time necessary for 50% mortality of snails (LT_{50}) was used to compare the various treatments (**4**). LT_{50} values for the tested pesticides could be arranged ascendinglly according to LT_{50} (in days) as follows: methomyl (2.58), cypermethrin (4.21) and imidacloprid (5.00). Also, this indicates that methomyl as poison bait has greatest efficacy followed by cypermethrin and imidacloprid against the tested snail (Table 2). Carbamate insecticides are known as cholinesterase inhibitors. They cause over stimulation of the nervous system, and the insect dies (3). Methomyl, for instance was developed as insecticide, was found to be very effective as molluscicides (7،9،14،16). In the present study, methomyl was superior over the other tested insecticides against *T. pisana* snails. These results are in accordance with those reported by several authors; Radwan *et al*. (14) who found that methomyl at 0.5% bran toxic baits among five oxime carbamate pesticides gave highly toxic effect against *T. pisana* under laboratory conditions. Indeed, Heiba *et al.*, (9); Genena and Mostafa (7); Radwan *et al.*, (16) showed that this compound as a poison baits was very toxic against *Eobania vermiculata* and *Monacha cantiana* snails under laboratory conditions.

Table 1. Comparative effects of some insecticides against the white garden snail, *Theba pisana*.

Insecticide	Bait concentration (%)	Mean percentage mortality after indicated days				Average percentage mortality per day*
		1	2	3	4	
Cypermethrin	0.065	10.00	13.33	20.00	33.33	19.16
	0.125	13.33	20.00	33.33	46.67	28.33
	0.25	20.00	26.67	33.33	53.33	33.33
	0.5	26.67	40.00	53.33	66.67	46.67
	1	33.33	46.67	73.33	86.67	60.00
Imidacloprid	0.065	6.67	13.33	13.33	26.67	15.00
	0.125	13.33	20.00	20.00	40.00	23.33
	0.25	16.67	20.00	26.67	46.67	27.50
	0.5	26.67	26.67	40.00	53.33	36.66
	1	33.33	40.00	46.67	73.33	48.33
Methomyl	0.065	10.00	13.33	20.00	46.67	22.50
	0.125	20.00	33.33	46.67	60.00	40.00
	0.25	26.67	40.00	46.67	66.67	45.00
	0.5	33.33	53.33	73.33	86.67	61.67
	1	40.00	60.00	80.00	100.0	70.00

*Average based on 30 snails treatment

control against the tested animal. The mortality percentages of the snails gradually increased with the increase of either bait concentration or exposure time. This indicates that the efficiency of the tested insecticidal baits are concentration and time-dependent. Varied mortality data were obtained among the pesticides tested. This is shown by the average daily percent mortality of *T. pisana* for cypermethrin, imidacloprid and methomyl ranged between 19.16 and 60.00, 15.00 and 48.33 and 22.5 and 70.00, respectively (Table 1). Probit analysis of the results indicates that the

3. Baits preparation:

Wheat-bran baits containing 5% molasses as attractant were formulated in the laboratory, for the three tested compounds in addition to the control one (5). These compounds were applied as toxic baits with five different concentrations (0.065, 0.125, 0.25, 0.25, 0.5 and 1% a. i.) to evaluate their comparative toxic effects against the land snail, *T. pisana* under laboratory conditions.

4. Testing procedure:

The molluscicidal toxicity of the tested compounds against *T. pisana* snails was performed according to the method published by Radwan (12). Plastic boxes of 10 cm diameter contained 200 g moist clay soil covered with 150 g wet peatmoss (5 cm height) were used. The peatmoss was regularly irrigated by tap water. Moisture was enough to keep the snails active and prevented adverse effect of moist or drying conditions on experimental snails and the baits. For each treatment, 30 animals were used and kept in three boxes (10 animals each) and about 5 g bait was provided to snails in each box. Each box tightly covered with polyethylene sheets having holes (pierced with a pin) about one cm apart. The cover kept the air saturated with moisture and prevented the snails from escape. Thirty animals in three boxes were used as control group containing wheat-bran bait with distilled water only. Preliminary experiments were carried out to establish the effective range of the tested compounds. Five different concentrations ranged from 0.065 to 1 % a.i. for each particular insecticide were prepared as poisonous baits. Animals failing to respond to a tactile stimulus by probing with a dissecting needle were considered dead (20). Death were counted every 24 hours and dead snails were removed. Since all the treatments did not cause rapid death, the trials extended to four days. Mortality percentages at each particular day were calculated. The efficacy of the tested insecticides at the different bait concentrations was compared. LC_{50} values with its fiducial limits and slope for each pesticidal treatment at each exposure time were computed using Probit analysis program based on Finney (6). LT_{50} values were also calculated for each compound based on the average percent mortality of different concentrations at each exposure time.

Results and Discussion

Efficacy of three insecticides applied as toxic baits at different exposure times against the white garden *T. pisana* snails are shown in Tables 1 and 2. No mortality of snails occurred in the control treatment. The three insecticidal baits showed satisfactory to good.

suitable (21). Today, this land snail species have become well known for most of the Libyan farmers because of their serious damage to many economic crops .

Control of snails or slugs on different crops is heavily dependent on the use of molluscicides that limit their destructive population below damaging levels. So, the synthetic molluscicides are still considered to be the most effective measures available at present for the control of terrestrial gastropods (14،7). Bait formulations of molluscicides or pesticides was the most effective application method in the field for controlling terrestrial gastropods rather any other technique (1). However, these synthetic molluscicides (like metaldehyde and methiocarb) may lead to problems of toxicity to non- target organisms in addition to deleterious long-term effects to the environment (10،18). Therefore, there is a need for new and safe pesticides or molluscicides with different mode of action.

Therefore, the present study was conducted to evaluate the comparative toxic effects of three commercially insecticides applied as toxic baits against the land snail, *T. pisana* under laboratory conditions.

Materials and Methods

1.The tested insecticides:

Three commercial insecticides belonging to three different chemical groups comprising one oxime carbamate; methomyl (Lannate® 90% SP), one synthetic pyrethroid; cypermethrin (Cyperkil® 25% EC) and one neonicotinoid; imidacloprid (Confidor® 20% EC) were used in the present study.

2. The tested animals

Specimens of the herbivorous land snail, *Theba pisana* (Müller) were collected, in spring 2013 when they are most active, from untreated nursery plants and farms in Al-Jable Al-Akhdar region, Libya. Snails of a similar shell size of approximately 12 mm length were chosen and identified according to the key reported by Godan (1983). They kept at least two weeks in aerated cages (40 x 30 x 30 cm, with 100 individuals per cage) for acclimatization under laboratory conditions (26-30 ºC and 63-65 RH) and fed on wheat-bran bait *ad libitum*. The snails were starved 24 hours before the experiments.

Comparative toxic effects of some insecticides against the land snail, *Theba pisana*

M. S. Mohamed[a] , M. A. Radwan[a,b *]
[a] Department of Plant Protection, Faculty of Agriculture, Omar Al-Mukhtar University, El-Beida, Libya
[b] Department of Pesticide Chemistry and Technology, Faculty of Agriculture (El-Shatby), Alexandria University, Alex., Egypt
* *Corresponding author Email address:mohamedradwan52008@hotmail.com*

Abstract

The comparative toxic effects of one synthetic pyrethroid (cypermethrin), one neonicotinoid (imidacloprid) and one carbamate (methomyl) as poison baits against the land snail, *Theba pisana* was studies under laboratory conditions. The mortality percentages were recorded daily up to 4 days and the LC_{50} as well as LT_{50} values were computed. The results showed that the average daily percent mortality of *T. pisana* for cypermethrin, imidacloprid and methomyl ranged between 19.16 and 60.00, 15.00 and 48.33 and 22.5 and 70.00, respectively. The efficacy of the tested insecticidal baits was concentration- and time-dependent. Methomyl was the most potent candidate, followed by cypermethrin and imidacloprid. These insecticides displaying LT_{50} values of 2.58, 4.21 and 5.0 days, respectively.

Introduction

The white garden snail *Theba pisana* (Muller 1774), belongs to Helicid family (Helicidae), is distributed all over the world especially in the Mediterranean region. It is not only a significant pest of different crops around the world (8), but also as a bioindicator for heavy metals pollution (11،15). This snail causes extensive damage to crops through their fouling of harvests and occasional direct feeding on seedlings. The snails climb up crops in summer to escape heat at the soil surface and are then harvested with the crop, causing it to be down-graded or rejected (2).

In Libya, the first survey of land gastropods indicated that the abundance of this snail in several locations, especially in coastal parts where they the conditions necessary for rapid reproduction are most