Bulletin of Faculty of Science, Zagazig University (BFSZU)
e-ISSN: 1110-1555
Volume-2023, Issue-1, pp-176-180
Research Paper DOI: **10.21608/bfszu.2022.170616.1197**

Molluscicidal Activity of Four Pesticides Against The Glassy Clover Snail, *Monacha Cartusiana* under Laboratory and Field Conditions, A Comparative Study.

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***ABSTRACT*: Using pesticides (chemical control) is one of the most strategies that used in integrated pest management programs to keep pest infestations below significant levels, that will not negatively impact the crops. The susceptibility of the pest populations to pesticides reduces with time, causing resistance to the recommended pesticides. One of the best solutions to avoid this resistance is to rotate between several chemical groups with different modes of action. In this study, evaluation of the efficacy of three pesticides belongs to different classes; Acetamiprid (neonicotinoids), Lambda (pyrethroids), and Plamic 5% (biocide) along with the recommended molluscicide, Newmyl (carbamate) were investigated against *Monacha cartusiana* under laboratory conditions at four concentrations (2, 4, 6, and 8%) and under field conditions at 8% concentration. The data revealed that; commercial pesticides showed high to moderate activity. Under laboratory conditions, Plamic 5%, and Lambda were the most active of tested compounds when compared with Newmyl. Where; Plamic 5%, and Lambda exhibited 100% mortality percentage at 4, 6, and 8 % concentrations after 3 days post-treatment. While Newmyl recorded 100 % mortality percentage at 8 % concentration only after the same period. Under field conditions, Acetamiprid exhibited satisfactory activity when compared with Newmyl followed by Plamic 5%. The mean of the residual effect of Newmyl was 75.96 % while, Acetamiprid and Plamic 5% recorded 56.54, and 47.52 %, respectively.**

KEYWORDS: Mollusca; Monacha Cartusiana; Resistance; Pesticides.

Date of Submission: 24-10-2022 Date of acceptance: 25-11-2022

I. INTRODUCTION

Terrestrial gastropods (land snail species), are considered one of the most serious agricultural pests that infesting economic crops, causing a lot of damage to field crops and horticultural plants, they are causing a noticeable reduction in yield and farmer income **(**1,2**)**. Moreover, they play an important role as an intermediate host for certain parasitic diseases (2,3**)**. *Monacha cartusiana* snail species is the most predominant species in Egypt, especially in Sharkia Governorate (4,5). Synthetic pesticides or molluscicides as chemical control are still the best used technique in cases of heavy attack to save crops (5,6). Mollusca develops mechanisms to detoxify pesticides and avoid toxicants (7**)**. Recently, the researchers directed their efforts to evaluate pesticides with different modes of action to overcome the problems associated with the common molluscicide. In this respect, we evaluated the efficacy of three pesticides belonging to different classes; Acetamprid (neonicotinoids), Lambad (pyrethroids), Plamic 5% (biocide), and compare their toxicity with Newmyl (carbamate), the recommended molluscicide, against *M. cartusiana* snails under laboratory and field conditions.

II. MATERIALS AND METHODS

2.1. Tested pesticides:

Pesticides were supplied from Central Agricultural Pesticide Laboratory.

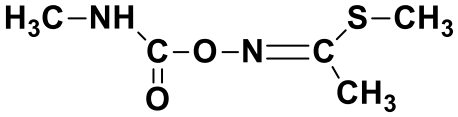
2.1.1. Newmyl (20%) (Carbamate):

Active ingredient:

Common name: methomyl

IUPAC name: (methyl *N*-(methylcarbamoyl) oxyethanimidothioate)

Chemical structure:



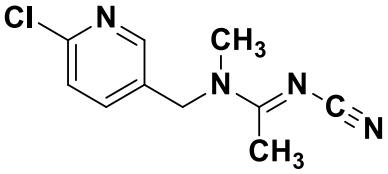
2.1.2. Acetamprid (Neonicotinoids):

Active ingredient**:**

Common name: Acetamprid

IUPAC name:(*E*)-*N*-((6-chloropyridin-3-yl)methyl)-*N*'-cyano-*N*-methyl acetimidamide

Chemical structure:



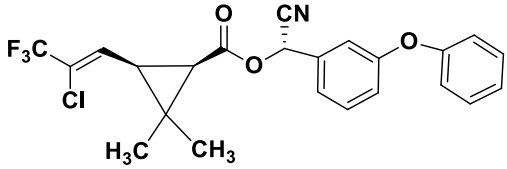
2.1.3. Lambda (pyrethroid):

Active ingredient:

Common name: λ-Cyhalothrin

IUPAC name: (1*R*,3*R*)-(*S*)- cyano(3-phenoxyphenyl)methyl 3-((*Z*)-2-chloro-3,3,3-trifluoroprop-1-en-1-yl)-2,2-dimethylcyclopropanecarboxylate.

Chemical structure:



2.1.4. Plamic 5% EC (Biocide):

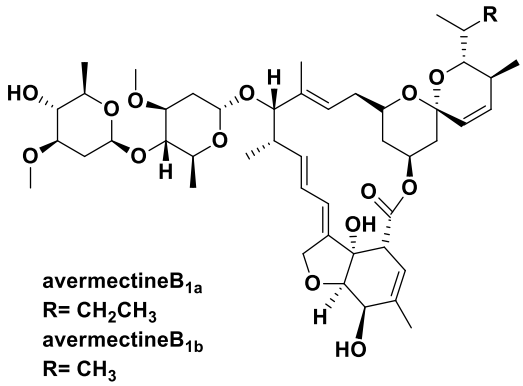
Active ingredient:

Common name: abamectin (avermectin B_{1a} (80%) and avermectin B_{1b} (20%))

IUPAC name: (10*E*,14*E*,16*E*) - (1*R*,4*S*,5′*S*,6*S*,6′*R*,8*R*,12*S*,13*S*,20*R*,21*R*,24*S*)-6′-[(*S*)-sec-butyl]-21,24-dihydroxy-5′,11,13,22-tetramethyl-2- oxo- (3,7,19-trioxatetracyclo[15.6.1.14,8.020,24] pentacosa-10,14,16,22-tetraene)-6-spiro-2′-(5′,6′-dihydro-2′H-pyran)-12-yl 2,6-dideoxy-4-*O*-(2,6-dideoxy-3-*O*-methyl-α-L-arabino-hexopyranosyl)-3-*O*-methyl-*α*-*L*-arabino-hexopyranoside

and (10*E*,14*E*,16*E*)-(1*R*,4*S*,5′*S*,6*S*,6′*R*,8*R*,12*S*,13*S*,20*R*,21*R*,24*S*)-21,22-dihydroxy-6′-isopropyl-5′,11,13,22-tetramethyl-2-oxo-(3,7,19-trioxatetracyclo[15.6.1.14,8.020,24]pentacosa-10,14,16,22-tetraene)-6-spiro-2′-(5′,6′-dihydro-2′H-pyran)-12-yl 2,6-dideoxy-4-*O*-(2,6-dideoxy-3-*O*-methyl-*α*-L-arabino-hexopyranosyl)-3-*O*-methyl-α-L-arabino-hexopyranoside

Chemical structure:



2.2. Rearing technique:

M. Cartusiana snails were collected from Sbeah village, Hehia district, Sharkia Governorate. The snails were transferred to the laboratory in muslin bags, individuals were kept in a glass container (50 x30 x 30

cm^3) with moist clay soil to a depth of 10 cm and covered with muslin cloth for prevent snail escaping. Snails were provided daily with fresh cabbage leaves for two weeks before tests for acclimatization (8**).**

2.3. Poisonous baits technique:

Four concentrations; 2, 4, 6 and 8% from Newmyl, Acetamiprid, Lambda, and Plamic 5% were prepared by incorporating the appropriate amount of each compound with wheat bran bait and 5 mL of molasses (sugar cane cane) as attractant material. Three plastic boxes (3/4 kg capacity) were used for each concentration. Five grams of each bait were spread into each box. Control treatment was prepared using bait free from any compound. Ten snails were introduced into each box, then covered with muslin cloth and secured with rubber band to prevent snails escaping. Mortality was observed using stainless steel needle according to El-Okda 1981 (9**)**. Death and dead snails were recorded and removed daily. Mortality percentages were calculated after 1, 3, 7, 14 and 21 days and corrected by Abbott's formula (10) as follow:

$$\% \text{ Mortality} = \frac{\text{mortality \% of treatment} - \text{mortality \% of control}}{100 - \text{mortality \% of the control}} X\ 100$$

2.4. Field Experiments.

This experiment was conducted in clover field highly infested with *M. cartusiana* at Sbeah village, Hehia district, Sharkia Governorate during April and May 2022 (the period of high population). High concentrations of the tested compounds were prepared as mentioned above and applied as baits. The field was irrigated one day before treatment. Before any treatment, live snails were counted in 50 × 50 cm^2, four replicates for each treatment; each replicate was supplied with plastic sheet with 50 gm of poisonous bait and the last four replicates for control were supplied with plastic sheets with brain baits without any compound. The number of living snails were counted after 1, 3, 7, 14, and 21 days. Reduction percentages were calculated according to (Henderson and Tillton, 1955) (11**)** as follows:

$$\textbf{\% Reduction} = [1 - (t_2 \times r_1) / (t_1 \times r_2)] \times 100$$

Whereas:

r_1 = number of alive snails before treatment in untreated plots

r_2 = number of alive snails after treatment in untreated plots.

t_1 = number of alive snails before treatment in treated plots.

t_2 = number of alive snails after treatment in treated plots.

2.5. Statistical analysis:

Variance analysis was computed using Costat computer program **6.311** copyright **1998-2005** CoHort Software 798 Lighthouse Ave. PMB 320, Monterey CA 93940, USA.

III. RESULTS AND DISCUSSION

3.1. Efficacy of tested pesticides against *M. cartusiana* under laboratory condition:

The toxicity of compounds; Newmyl, Lambda, Acetamiprid, and Plamic 5% were evaluated against the glassy clover snail, *M. cartusiana* as baits at four concentrations (2, 4, 6, and 8 %) under laboratory conditions. The mortality percentage was listed in table (**1**). The tested compounds showed high to moderate activity and the result revealed that, the mortality is directly proportion with exposure time and concentration of the compounds. Plamic 5%, and Lambda are the most effective compounds which is agree with Ismail and Hegab, 2006 who recorded that, Abamectin is more toxic when compared with the synthetic pyrethroid (alphacypermethrin) (12). However the data indicated that, Newmyl is more active than Acetamiprid, this is in harmony with Sallam *et al.*, 2015 who reported that, Newmyl is less effective than Abamectin and more effective than Imidacloprid (neonicotinoids derivative) when evaluated against *M. obstracta* (13**)** and also in agree with Shaker *et al.*, 2015 who reported that, methomyl (carbamates derivative) is more effective than Acetamiprid when evaluated against *E. vermiculata* (14). Plamic 5%, and Lambda recorded 100 % mortality for 3 concentrations (4, 6, and 8 %) after three days of treatment. Also Newmyl showed 100 % mortality after 3 days at 8 % concentration while Acetamiprid was the least effective compound where the mortality recorded 43.30 % at concentration of 8 %, after 3 days of treatment.

Table (1): Mortality percentage of four pesticides against *M. cartusiana* under laboratory conditions:

compounds	conc. %	Mortality percentage after treatment (periods in days)					Mean
		1	3	7	14	21	
Newmyl	2.00	0.00	33.30	60.00	66.60	66.60	45.30[b]
	4.00	20.00	46.60	60.00	73.30	80.00	55.98[b]
	6.00	40.00	66.60	73.30	80.00	100.00	71.98[ab]
	8.00	93.30	100.00	100.00	100.00	100.00	98.66[a]
L.S.D.$_{(0.05)}$		29.09					
Lambda	2.00	6.60	33.30	66.60	80.00	80.00	53.30[b]
	4.00	46.60	100.00	100.00	100.00	100.00	89.32[a]
	6.00	73.30	100.00	100.00	100.00	100.00	94.66[a]
	8.00	80.00	100.00	100.00	100.00	100.00	96.00[a]
L.S.D.$_{(0.05)}$		28.74					
Acetamiprid	2.00	0.00	23.30	26.60	26.60	46.60	24.62[a]
	4.00	3.30	33.30	40.00	46.60	53.30	35.30[a]
	6.00	13.30	43.30	50.00	53.30	60.00	43.98[a]
	8.00	10.00	43.30	56.60	63.30	70.00	48.64[a]
L.S.D.$_{(0.05)}$		26.35					
Plamic 5%	2.00	26.60	66.60	66.60	100.00	100.00	71.96[a]
	4.00	60.00	100.00	100.00	100.00	100.00	92.00[a]
	6.00	53.30	100.00	100.00	100.00	100.00	90.66[a]
	8.00	53.30	100.00	100.00	100.00	100.00	90.66[a]
L.S.D.$_{(0.05)}$		30.82					

The same letter in the same column for each compound means not significant at $P < 0.05$

3.2. Evaluation of the highest concentration of pesticides against *M. cartusiana* under field conditions.

The highest concentrations of commercial pesticides that applied under laboratory conditions were applied in the field against *M. cartusiana*. The obtained results are summarized in table (**2**). The mean of the initial effect indicated that, Newmyl is the most potent compound by 52.48 % while Plamic 5% was lowest one by 3.33 %. By the end of the experiment, means of the residual effect cleared that, Newmyl was the most effective compound by 75.69 % followed by Acetamiprid with 56.54 %; then Plamic 5 % with 47.52% while Lambda was the lowest one. This is in harmony with the results obtained by Ismail *et al.*, 2005 who reported that methomyl recorded high residual effect against *M. cartusiana* under field conditions (6). The opposite behavior of Lambda under field condition rather than laboratory condition could be attributed to its repellency properties (15) where under field conditions snails have another source of food while under laboratory conditions they have no choice.

Table (2): Efficacy of the highest concentrations (8 %) of certain pesticides against *M. cartusiana* under field conditions:

Compounds	% Reduction in days		Mean of initial effect %	% Reduction in days			Mean of residual effect %	General mean
	1	3		7	14	21		
Newmyl	49.65	55.3	52.48	64.09	66.9	96.08	75.69	66.4
Lambda	15.41	35.55	25.48	35.55	3.33	3.33	14.07	18.63
Acetamiprid	3.33	19.44	11.39	82.42	83.88	3.33	56.54	38.48
Plamic 5 %	3.33	3.33	3.33	23.58	37.63	81.36	47.52	29.85

V –CONCLUION

To overcome the resistance associated with the recommended molluscicide (Newmyl), we evaluated four pesticides belong to different classes against *M. cartusiana* under laboratory at 2, 4, 6, and 8 % concentrations and under field conditions at 8% concentration. Under laboratory conditions, the results revealed that Plamic 5%, and Lambda showed high efficacy compared with Newmyl while Acetamiprid was the lowest one. Unexpectedly, Acetamiprid under field conditions exhibited sufficiently good activity (mean of the residual effect 56.54 %) when compared with Newmyl (mean of the residual effect 75.69 %).

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