Zagazig J. Agric. Res., Vol. 51 No. (2) 2024 225-236

Plant Protection and Pathology Research

Available online at http://zjar.journals.ekb.eg
http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

MOLLUSCICIDAL DETERMINATION OF CERTAIN PESTICIDES AGAINST *Monacha cartusiana* (MÜLLER) IN DIFFERENT VEGETABLE CROPS UNDER FIELD CONDITIONS AT SHARKIA GOVERNORATE, EGYPT

Hamdi A. Abd El-Hamed[1*], M.A. Hendawy[2], M.H. Soliman[1] and E.M. Abd El-Aal[2]

1. Plant Prot. Res. Inst., Agric. Res. Cent., 12311 Dokki, Giza, Egypt
2. Plant Prot. Dept., Fac. Agric., Zagazig Univ., Egypt

Received: 11/02/2024; Accepted: 06/03/2024

ABSTRACT: Field experiments had been conducted using different pesticides commonly used on vegetable crops searching for suitable compound could be successfully used in controlling of the glassy clover snail, *Monacha cartusiana*, during the activity period at Sharkia Governorate. The obtained data clearly showed, the percent reductions of snail under field conditions were significantly differed from one pesticide to another and from vegetable crop to another more over the date of examination after application was also affected in addition to; densities of infestation, the crop cultivation rates, ecological behavior of the snails and types of dispersion in each crop. Since, the tested pesticides reduced snails' population in squash with varying degrees, the general means of percent reduction three days after application recorded maximum reduction with malathion and methomyl with 57.26 and 53.61% reduction, while the least effects were recorded with imidacloprid and acetamiprid with 31.25 and 27.07%. The same trend was observed two and three weeks after application with a slight increase or decrease in reduction percentages with all tested compounds. On the other site, the tested pesticides reducing populations on cabbage one week after application with maximum reduction by methomyl and malathion, 56.09 and 52.51%, while the least effects were recorded with acetamiprid and imidacloprid with 30.61and 26.51% reduction, respectively. When regarding reducing in snails' populations on eggplant three weeks after application, the highest effect was recorded with malathion; moderate effect was with fipronil while imidacloprid showed the least effect in reduction. As soon as, on tomato one week after application, the reduction recorded with malathion was 57.25% followed by methomyl 53.60%, while with imidacloprid 31.25% and acetamiprid 27.07% reduction percentages. On green pea the efficacy of pesticides after the third week of application reducing the populations with highest effect by methomyl; moderate effect with fipronil while the least effect recorded with imidacloprid. While in spinach one week after application the reduction percentages recorded 59.24% with methomyl, 55.47% with malathion, 32.33% with acetamiprid and 28.01% reduction, with imidacloprid moreover the same trend was observed two and three weeks after application. Generally, the molluscicidal determination of all tested pesticides in controlling the glassy clover snail, *M. cartusiana* infesting vegetable crops under field conditions at Sharkia Governorate could be arranged as; total general means of percent reduction, after four weeks of application as follows: Methomyl > Malathion > Emamectin benzoate > Fipronil > Acetamiprid and Imidacloprid with percentage reductions of 59.06, 54.24, 47.77, 43.26, 30.75 and 28.96%, respectively.

Key words: Molluscicides, vegetables, land snails, Sharkia Governorate, *Monacha cartusiana*.

INTRODUCTION

Land gastropods contains snails and slugs are become ones of the most dangerous agricultural pests caused harmful damage to agricultural crops in different countries of the world (**Barker, 2002; Speiser and Kistler, 2002; Flint, 2011; Baker, 2012; Schweizer *et al*., 2019**). The importance of these snails for its fast dispersal and increased drastically in especially at last decades

*** Corresponding author: Tel. :**+201093769070
E-mail address: hamdisakarana@gmail.com

(**Garthwaite and Thomas, 1996; Haszprunar, 2020**), also for the damage caused by the snails which due to their feeding on crops vegetation and fruits, contamination by its bodies or by slime or feces that led finally to deterioration the quality and quantity of products (Iglesias *et al*., 2003 and Heiba, *et al.*, 2018). Its mucous causes also unfavorable smell could prevent men and farm animals from direct feeding on crops (**Sallam *et al*., 2009; Abo Zaid *et al*., 2021**). Snails also have increased markedly and causing huge damage for different field crops in many Governorates of Egypt (**Eshra, 2014; Eshra *et al*., 2015; Abou Senna *et al*., 2016; Fathey, *et al*., 2020**).

For that, molluscicides extracted as natural products were used in controlling of these snail species and other compounds as biocides, bactericides, and fungicides were also examined. But control of the land snails depends largely on pesticides or specific molluscicides (**Radwan *et al*., 1992; El-Wakil and Attia, 1999; Moran *et al*., 2004; El-Shahaat *et al*., 2005; El-Shahaat *et al*., 2009; Eshra, 2014**). Also, many reports detecting molluscicidal effects formulated especially as poison baits (**Miller *et al*., 1988; Hammond *et al*., 1996; Okka, 2005; Geasa *et al*., 2013**). Molluscicides against land snails are delivered as; sprays or dust, but poison baits techniques still the most effective (**Barker, 2002; Heiba *et al*., 2002; Radwan *et al*., 2008; Ismail *et al*., 2014**), moreover it is simple for use, focal on treatment not for all area wide, thus it is usually with low cost (**Mortada *et al*., 2005**).

That is why, field experiments had been conducted using different pesticides that commonly used on vegetable crops, for searching the suitable compound could be successfully used in controlling the glassy clover snail, *M. cartusiana*, during the activity period of the snails at Sharkia Governorate.

MATERIALS AND METHODS

Field experiments had been carried out using different pesticides to search for suitable compound which could be used successfully in controlling the glassy clover snail, *M. cartusiana*, infesting certain vegetable crops i.e.; squash (zucchini), *Cucurbita pepo*; cabbage, *Brassica oleracea var. capitata* during February 2022 in El-Hamadeen village; eggplant, *Solanum melongena*; tomato, *Lycopersicon esculetum* during March 2022 in El-Sady village; green pea, *Pisum sativum* and spinach, *Spinacia oleracea* during November 2022 in Nazlet Khial village. The experimental areas were highly infested with the snail species, and all located in Abou-Kapper district at Sharkia Governorate.

Molluscicidal Determination of Certain Pesticides Against *M. cartusiana*

The experimental site for each vegetable crop was divided into 2 plots, each of about half feddan, about (50 m^2) for each, and the same area was left between each other in a randomized block design and the field was irrigated one day before treatment, to measure the effect of tested pesticides in diminishing populations of the glassy clover snail one plot was treated with toxicants, while the other was left without treatment as control.

Molluscicidal Activity

The tested toxicants were applied as poisonous baits at concentration of 2% ai. (2 parts of toxicant + 5 parts of sugar-cane syrup + 93 parts of wheat brane) for each compound (Fepronil EPC, fipronil 25% L); (Imidastar, imidacloprid 35% SC); (Lannate, methomyl 90% SW); (Mlason, malathion 57% EC); (Mospilan, acetamiprid 20% SP) and (Proclaim, emamectin benzoate 5% SG), while control was designed by the same manner without pesticides, baits were offered on plastic trays each one contain (100 gm) in rate of (2 m^2) for each bait. Treatments of pesticides and control were replicated three times, numbers of dead and alive snails were counted using (0.25m^2) quadrate (**Staikou and Lazaridou- Dimitriadou, 1990**) placed in different directions and adjacent to the bait and entailed 24 hrs. before and after applications and then at intervals of two days during the experimental time of four weeks, all snails found on plants or on soil surface in the quadrates were counted. Percent reduction in population density of the snail was calculated according to the formula given by **Henderson and Tillton (1955)** as follow:

Reduction (%)=[1- (t2 x r1) / (t1 x r2)] x 100. Where; (r1 and r2) = number of alive snails (before and after) treatment in untreated plots, (t1 and t2) = number of alive snails (before and after) treatment in treated plots. Data were statistically analyzed using (F) test and the least significant differences between treatments were calculated at (5%) level according to **Duncan (1955)**.

Tested Compounds

The tested compounds were obtained as fresh formulated products directly from market or from the central agricultural pesticides' laboratory, Dokki, Giza, Egypt, classes of these compounds, chemical group, common name, trade name, formulation type and chemical name were as follows:

Fepronil EPC, (Fipronil, 25% L), insecticide

Chemical formula: ($C_{12}H_4C_{l2}F_6N_4OS$)

Chemical name: 5-Amino-1-[2,6-dichloro-4-(trifluoromethyl) phenyl]-4-(trifluoro methane sulfinyl)-1H-pyrazole-3-carbonitrile.

Imidastar, (Imidacloprid, 35% SC), insecticide

Chemical formula: ($C_9H_{10}ClN_5O_2$)

Chemical name: N-{1-[(6-Chloro-3-pyridyl) methyl]-4,5-dihydro imidazol-2-yl} nitroamide.

Lannate, (Methomyl, 90% SW), insecticide

Chemical formula: ($C_5H_{10}N_2O_2S$)

Chemical name: methyl (1E)-N- (methyl carbamoyloxy) ethan imido thioate

Mlason, (Malathion, 57% EC), insecticide

Chemical formula: ($C_{10}H_{19}O_6PS_2$)

Chemical name: Diethyl 2- [(dimethoxy phosphor thioyl) sulfanyl] butan edioate.

Mospilan, (Acetamiprid, 20% SP), insecticide

Chemical formula: ($C_{10}H_{11}ClN_4$)

Chemical name: N-[(6-chloro-3-pyridyl) methyl]-N'-cyano-N-methyl-acetamidine.

Proclaim, (Emamectin benzoate, 5% SG), insecticide

Chemical formula: ($C_{49}H_{75}NO_{13}$)

Chemical name: 4″-Deoxy-4″-epi-methylamino-avermectin B1; Epi-methylamino-4″-deoxy ivermectin; MK 243; EMA; GWN 1972.

RESULTS AND DISCUSSION

A series of field trails were designed to study the efficacy of different pesticides in controlling the land snail, *M. cartusiana*, infesting certain vegetable crops i.e.; squash (zucchini), *C. pepo*; cabbage, *B. oleracea* var. *capitata* during February; eggplant, *S. melongena*; tomato, *L. esculetum* during March; green pea, *P. sativum* and spinach, *S. oleracea* during November, 2022 during the activity period of the snails in Abou-Kapper district at Sharkia Governorate.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Squash Crop

Data presented in Table 1 clearly showed that, the tested pesticides reduced populations of *M. cartusiana* infesting squash to varying degrees, since percent reduction significantly differed from one pesticide to another and from date of examination to another. The general means of percent reduction after application with three days recorded maximum reduction with malathion and methomyl with 57.26 and 53.61%, respectively while the least effects were recorded with imidacloprid and acetamiprid with 31.25 and 27.07%, respectively. The same trend was observed two weeks after application with a slight increase or decrease in percentage reduction with all tested compounds. After three weeks of application the percent reduction recorded the highest effect with malathion and methomyl; moderate effect with fipronil and emamectin benzoate while the least effect recorded with imidacloprid and acetamiprid. Generally, the molluscicidal efficiency of the tested pesticides according to their general means of percent reduction after finished the trails could be arranged as follows: malathion > methomyl > fipronil > emamectin benzoate > imidacloprid and acetamiprid with percentage reduction of 59.89, 55.12, 49.52, 46.82, 40.87 and 35.40%, respectively.

Table 1. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting squash (zucchini) crop at Sharkia Governorate during February 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	18.56	27.07	35.46	50.00	27.00	37.48	35.40e
Emamectin benzoate, (5% SG)	21.66	35.80	46.90	66.13	35.71	49.58	46.82c
Fipronil, (25% L)	22.42	45.51	59.62	74.06	45.39	63.02	49.52bc
Imidacloprid, (35% SC)	20.17	31.25	40.94	57.73	31.17	43.28	40.87d
Malathion, (57% EC)	25.46	57.26	63.01	69.76	57.11	60.29	59.89a
Methomyl, (90% SW)	23.93	53.61	66.23	66.02	53.47	58.24	55.12ab

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Cabbage Crop

Data in Table 2 showed that the tested pesticides reduced populations of *M. cartusiana* infesting cabbage to different degrees and differed from one pesticide to another and date to another. The general means of percent reduction one week after application recorded maximum reduction with methomyl and malathion with 56.09 and 52.51%, respectively while the least effects were recorded with acetamiprid and imidacloprid with 30.61and 26.51%, respectively. The same trend was observed two weeks after application with all tested compounds. While, after three weeks of application, the percent reduction recorded the highest effect with methomyl; moderate effect with emamectin benzoate while the least effect recorded with imidacloprid, respectively. Generally, the molluscicidal efficiency of the tested pesticides according to their general means of percent reduction four weeks after application, could be arranged as follows: methomyl > malathion > emamectin benzoate > fipronil > acetamiprid and imidacloprid with percentage reduction of 56.27, 52.69, 44.73, 35.19, 30.71and 26.60%, respectively.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Eggplant Crop

Data in Table 3 showed, the tested pesticides reduced populations of *M. cartusiana* infesting eggplant to varying degrees, the general means of percent reduction one week after application recorded maximum reduction with malathion 61.09% followed by methomyl 57.20%, while least effects were recorded with imidacloprid 33.35% and acetamiprid 28.88%. Three weeks after application the percent reduction recorded the highest effect with malathion and methomyl; moderate effect with fipronil and emamectin benzoate while the least effects recorded with imidacloprid and acetamiprid, respectively, the molluscicidal efficiency of all tested pesticides according to their general means of percent reduction four weeks later, could be arranged as follows: malathion > methomyl > fipronil > emamectin benzoate > imidacloprid and acetamiprid with percentage reduction of 58.45, 54.72, 46.46, 36.55, 31.90 and 27.63%, respectively.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Tomato Crop

The tested pesticides shown in Table 4, reduced the populations of *M. cartusiana* infesting tomato with varying degrees and differed from pesticide to another. General means of percent reduction one week after application recorded the maximum reduction with malathion 57.25% followed by methomyl 53.60%, while the least effects were recorded with imidacloprid 31.25% and acetamiprid 27.07%. The same trend was observed two and three weeks after application with an increase or

Table 2. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting cabbage crop at Sharkia Governorate during February 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	24.66	27.09	30.61	40.41	23.84	31.62	30.71de
Emamectin benzoate, (5% SG)	27.41	39.45	44.58	58.84	34.72	46.05	44.73c
Fipronil, (25% L)	26.48	31.03	35.07	46.29	27.31	36.22	35.19d
Imidacloprid, (35% SC)	22.68	23.46	26.51	35.00	20.65	27.39	26.60e
Malathion, (57% EC)	29.25	46.47	52.51	61.32	40.90	54.24	52.69ab
Methomyl, (90% SW)	31.12	49.63	56.09	64.03	43.68	57.93	56.27a

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

Table 3. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting eggplant crop at Sharkia Governorate during March 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	16.48	29.77	28.88	31.19	21.21	27.09	27.63e
Emamectin benzoate, (5% SG)	19.24	39.38	38.20	41.26	28.05	35.84	36.55d
Fipronil, (25% L)	19.91	50.06	48.56	52.44	35.66	45.56	46.46c
Imidacloprid, (35% SC)	17.91	34.38	33.35	36.01	24.49	31.28	31.90de
Malathion, (57% EC)	22.61	62.98	61.09	65.98	44.87	57.31	58.45a
Methomyl, (90% SW)	21.25	58.97	57.20	61.78	42.01	53.66	54.72ab

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

Table 4. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting tomato crop at Sharkia Governorate during March 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	15.16	30.07	27.07	35.46	15.88	26.13	26.92e
Emamectin benzoate, (5% SG)	17.70	39.77	35.80	46.89	21.01	34.57	35.61d
Fipronil, (25% L)	18.32	50.56	45.51	59.61	26.71	43.94	45.27c
Imidacloprid, (35% SC)	16.48	34.72	31.25	40.94	18.34	30.17	31.08de
Malathion, (57% EC)	20.80	63.61	57.25	69.00	33.60	55.28	56.95a
Methomyl, (90% SW)	19.55	59.56	53.60	67.22	31.46	51.76	53.32ab

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

decrease in percentage reduction, the molluscicidal efficiency of the tested pesticides according to their general means of percent reduction four weeks after application, could be arranged as follows: malathion > methomyl > fipronil > emamectin benzoate > imidacloprid and acetamiprid with percentage reduction of 56.95, 53.32, 45.27, 35.61, 31.08 and 26.92%, respectively.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Green Pea Crop

Data in Table 5 showed the pesticides that reduced the populations of the snails infesting green peas with varying degrees and different effect. General means of percent reduction one week after application recorded 60.48% with methomyl followed by 59.38% with malathion, while the least effects were recorded with acetamiprid 35.20% and imidacloprid 30.48%. The same trend was observed two and three weeks after application with an increase or decrease in percentage reduction. The molluscicidal efficiency of the tested pesticides according to their general means of percent reduction four weeks after application, could be arranged as follows: methomyl > malathion > emamectin benzoate > fipronil > acetamiprid and imidacloprid with percentage reduction of 59.03, 55.27, 46.92, 36.91, 32.22 and 27.91%, respectively.

Efficiency of Certain Pesticides in Reducing Populations of *M. cartusiana* on Spinach Crop

Data in Table 6 showed, the tested pesticides reduced the populations of *M. cartusiana* infesting spinach with varying degrees. Means of percent reduction one week after application recorded maximum reduction with methomyl 59.24% followed by malathion 55.47%, respectively while the least effects were recorded with acetamiprid 32.33% and imidacloprid 28.01% reduction. The molluscicidal efficiency of the tested pesticides according to general means of percent reduction four weeks after application, could be arranged as follows: methomyl > malathion > emamectin benzoate > fipronil > acetamiprid and imidacloprid with percentage reduction of 57.89, 54.20, 46.01, 36.19, 31.60 and 27.37%, respectively.

Molluscicidal Determination of All Tested Pesticides Against *M. cartusiana* Infesting Vegetable Crops Under Field Conditions at Sharkia Governorate

Searching for the more effective pesticides that commonly used in vegetable crops in controlling of the glassy clover snail, *M. cartusiana* for successful programs; a serious of control was applied using different chemical compounds for controlling *M. cartusiana* on most popular vegetable crops under field conditions as shown in Fig. 1, that could be summarized, the efficiency of all tested compound as total means of percent reduction of snail species, after the whole period of examination (four weeks), under field conditions on all vegetable crops, could be arranged as follows: Methomyl > Malathion > Emamectin benzoate > Fipronil > Acetamiprid and Imidacloprid with percentage reduction of 59.06, 54.24, 47.77, 43.26, 30.75 and 28.96%, respectively.

Before discussing the obtained results, it is important to mention that, problems caused by snails on agricultural crops were reported by many authors at different countries of the world (**Baker, 1989; Newman *et al*., 1994; Castielleio *et al*., 1996**), moreover in Egypt land snails occurred at different Governorates attacking many agricultural crops (**Ismail *et al*., 2011; Rady *et al*., 2014; Kadry, *et al*., 2018; Abd El-Haleim *et al*., 2022**).

Our obtained results are in general agree with those reported by many authors. **Godan (1983)** showed, using herbicides not only kill weeds but also mollusks either through the animal skin or by ingestion through the intestine. **Radwan *et al*. (1992)** found that brane toxic baits of five oxime carbamate pesticides including oxamyl gave highly toxic effect against *Theba pisana*, organophosphorus compounds gave highest efficiency in controlling *M. cartusiana*. Moreover, **Abdallah *et al*. (1999), Abd El-Monem (2016) and Gaber *et al*. (2022)** tested twenty-four compounds belonging to carbamates, organophosphates, chlorinated hydrocarbons against *E. vermiculata* and *T. pisana*. They illustrated that aldicarb, methomyl, monocrotophos and paraquate were the most toxic compounds against both tested snail species. On the other hand, similar results had been recommended by **Aioub *et al.* (2000) and Elsayed *et al*. (2022)**.

Table 5. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting green pea crop at Sharkia Governorate during November 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	22.44	30.34	35.20	42.20	20.68	32.69	32.22de
Emamectin benzoate, (5% SG)	24.94	44.18	51.25	61.45	30.11	47.61	46.92c
Fipronil, (25% L)	24.10	34.76	40.32	48.34	23.69	37.45	36.91d
Imidacloprid, (35% SC)	20.64	26.28	30.48	36.55	17.91	28.31	27.91e
Malathion, (57% EC)	26.62	52.05	59.38	72.39	35.47	56.08	55.27ab
Methomyl, (90% SW)	28.32	55.59	60.48	77.32	37.89	59.90	59.03a

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

Table 6. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting spinach crop at Sharkia Governorate during November 2022

Compounds	Control	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Acetamiprid, (20% SP)	26.23	29.13	32.33	39.45	24.85	32.21	31.60de
Emamectin benzoate, (5% SG)	29.16	42.42	47.09	57.45	36.19	46.91	46.01c
Fipronil, (25% L)	28.17	33.37	37.04	45.19	28.47	36.90	36.19d
Imidacloprid, (35% SC)	24.13	25.23	28.01	34.17	21.52	27.90	27.37e
Malathion, (57% EC)	31.12	49.97	55.47	67.67	42.63	55.26	54.20ab
Methomyl, (90% SW)	33.11	53.37	59.24	72.27	45.53	59.02	57.89a

* Initial control effect = Mean (%) reduction during the first three days.
* Residual control effect = Mean (%) reduction during the rest periods.
* General means followed by the same letter (s) are not significantly different at 0.05 level, according to **Duncan (1955)**.

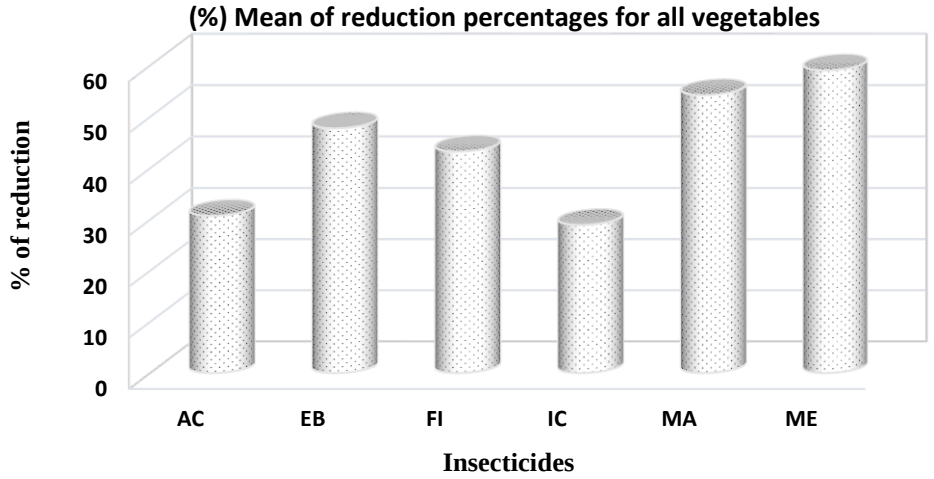

Fig. 1. Molluscicidal determination of certain pesticides against *M. cartusiana* infesting certain vegetable crops at Sharkia Governorate

Where, AC = Acetamiprid., EB = Emamectin benzoate., FI = Fipronil., IC = Imidacloprid., MA = Malathion., ME = Methomyl.

Population density of terrestrial snails is obviously increased during spring months as compared to low or moderate values during winter and autumn months (**Ghamry *et al*., 1993; Abo Bakr, 2011**) therefore, application of molluscicides effectively applied during the activity period of the snails. When discussing the results correlated with vegetable variety, host preference for land snails was discussed by many authors (**Ghamry *et al*., 1994; Sean *et al*., 2015; Ibrahim *et al*., 2017**) who reported that, snails fed on lettuce showed higher assimilation efficiency than those fed on *Urtica dioica*, leaves of pea and lettuce were most preferable food for *M. cartusiana*, and leaves of lettuce and cabbage were the most favorable for *M. cartusiana* as compared with other tested food leaves.

While testing attractive materials in poisonous baits for reducing population of snails, *H. vestalis.* **El-Sebae *et al.* (1982)** found, bran baits containing raddish and ragee elkone gave higher percent mortality to snail than nokhalah and germah. **Godan (1983)** mentioned that molasses and wheat bran were considered the most effective in mixtures with molluscicides in poisonous baits techniques. **Asran (1994)** indicated that bran was the most preferable bait for *H. aspersa* followed by crushed wheat and crushed maize, sugar-cane syrup was the most attractive additive substance followed by molasses. When discussing the suitable time of application, it is worthy to mention that snails aestivate during summer months starting from June and the animals retract into their shell and seal the shell aperture with one or more epiphragms (**Mahrous *et al.*, 2006**). Also, **Carman (1965)** illustrated that spraying chemicals during summer proved no value to control land snails. Moreover, **Shah (1992) and Tillier *et al.* (1995)** reported that physical control of land snails by creating barriers of bare around the crop was most effective during activity periods.

Finally, integrated pest management (IPM) has become an economic necessity, and vital for modern agriculture, including different methods of control for suppress snails' populations to non-damaging levels, and using pesticides one of these methods, in this study the efficacy of different pesticides commonly used on vegetable crops in controlling the glassy clover snail, *M. cartusiana* at Sharkia Governorate showed, different percent reductions from one pesticide to another and from vegetable crop to another more over the date of examination after application was also affected in addition to; level of infestation, crop cultivation rate or density, food preference of snails, ecological behavior and types of dispersion for snails population on each crop during the activity period in addition to, the control methods that used and methods of application, as mentioned by many authors (**Prakash and Rao, 1997; Batish *et al.*, 2008; Keith *et al*., 2009; Howlett, 2012**).

REFERENCES

Abdallah, E.M., F.A. Kassem, H.B. El-Wakil and Y. Abo-Baker (1999). Molluscicidal potentiality of several pesticides against *E. vermiculata* and *T. pisana*. Annal Agric. Sci. Cairo, 263-276.

Abd El-Haleim, S.M., K. Weshahy, H.M. Emam and R.F. Ali (2022). Population dynamics of abundant three terrestrial snail species in horticultural fields at Beheira and Giza Governorate, Egypt. Pak. J. Biol. Sci., 25: 765-775 doi: 10.3923/pjbs.2022.765.775.

Abd El-Monem, M.K. (2016). Impact of methomyl, lannate on physiological parameters of the land snail *Eobania vermiculata*. J. Basic and Appl. Zool., 74: 1–7. http: //dx.doi.org/ 10. 1016/ j. jobaz.2015.12.005.

Abo Bakr, Y. (2011). Histopathological changes induced by metaldehyde in *Eobania vermiculata* (Müller 1774). Alex. Sci. Exch. J., 32: 300–310. https://doi.org/ 10.21608/ asejaiqjsae. 2011.2634.

Abou Senna, F.M., A.H. Al-Maraghy, Sh.A. Ismail and M. Abed (2016). Survey and population dynamic of terrestrial gastropods infesting certain crops at Sharkia Governorate, Egypt. Int. J. Adv. Res. 4 (11), 641-649 http: //dx.doi.org/10.21474/ijar01/2128.

Abo Zaid, A.B., I.S. El-Hawary, M.E. Mahrous and M.F. El-Sheikh (2021). Field observation on biology and ecology of terrestrial snails infesting field and vegetable crops at Gharbia Governorate Egypt. Acad. J. Biol. Sci., 13 (2): 95-103 doi:10.21608/eajbsz.2021. 196691. Egypt.

Aioub, A.A., S.A. Ismail and A.A. Mohamdein (2000). Toxicological and histological studies on some pesticides-treated land snails. Proc. ICBS, 1(2) : 19-38.

Asran, F.D. (1994). Studies on harmful terrestrial snails and their management on Egyptian agricultural lands. M.Sc. Thesis, Inst. Environ. Stud. and Res. Ain Shams Univ., Cairo, 125.

Baker, H.G. (1989). Damage, population dynamics, movement, and control of pest helicid snails in Southern Australia. In: British Crop Protection Council (BCPC) Monograph, No. 41. Slugs and Snail Pests in Agric.. Ed. Henderson, I.F., 175-185.

Baker, H.G. (2012). The population dynamics of the Mediterranean snail, *Cernuella virgata* (da costa, 1778) (hygromiidae), in continuous-cropping rotations in South Australia. J. Molluscan Studies (2012) 78: 290 –296 doi: 10.1093/mollus/eys015.

Barker, G.M. (2002). Molluscs as crop pests. CAB International Publishing, 468.

Batish, D.R., H.P. Singh, R.K. Kohli and S. Kaur (2008). Eucalyptus essential oil as a natural pesticide. Forest Ecol. and Manag., 256 (12):2166–2174 doi:10.1016/ j. foreco. 2008. 08.008.

Carman, G.E. (1965). Electrical trapping device for land snails. J. Econ. Entomol., 58: 786-787.

Castielleio, J., I. Seijas and F. Villoch (1996). Slug and snail pests in Spanish crops and their economic importance. In: British Crop Protection Council (BCPC) Monograph, No. 66. Slugs and Snail Pests in Agriculture. Ed. Henderson, I.H., 327-332. 24-26, Sept.1996.

Duncan, D.B. (1955). Multiple range and multiple F test. Biometrics, 11: 1-47.

Elsayed, T., A. Helmy, A. Mona, A. Mohamed, H. Ayyad, B. Mohamed, S. Rajender, F. Varma and P. Jia Hong (2022). Molluscicidal and biochemical effects of green-synthesized F-doped ZnO nanoparticles against land snail *Monacha cartusiana* under laboratory and field conditions. Environ. Pollution, 308: 119691. https://doi.org/10.1016/j.envpol. 2022. 119691.

El-Sebae, M.M., M.M. El-Okda and A.S. Marie (1982). Local formulation of three carbamoylated oximes as terrestrial molluscicides. Agric. Res. Rev., 60 (1): 85-92.

El-Shahaat, M.S., E.H. Eshra and Y. Abo-Bakr (2005). Impact of Basamide and methomyl bait on non-target pests and microbiological processes in soil. Egypt. J. Agric. Res., 83: 1007–1016.

El-Shahaat, M.S., N.A. Aly, E.H. Eshra, H.A. Mesbah and E.I. Ghoneim (2009). Toxicity of certain copper fungicides and other pesticides to terrestrial snails. J. Agric. Sci. Mansoura Univ. 34 (5), 5501–5507.

El-Wakil, H.B. and A.M. Attia (1999). Effect of selected insecticides on terrestrial snails *Eobania vermiculata* Müller and *Theba pisana* Müller with respect to some morphological changes in Egypt. J. Environ. Sci. and Health. Part B, Pesticides, Food Contaminants, and Agric. Wastes, 34 (1): 47-60.

Eshra, E.H. (2014). Toxicity of methomyl, copper hydroxide and urea fertilizer on some land snails. Ann. Agric. Sci., 59 (2):281–284. http://dx.doi.org/10.1016/j.aoas.2014.11.017.

Eshra, E., H. Abo Bakr and M.S. El-Shahaat (2015). Seasonal incidence and chemical control of land snails in pear orchards at Alexandria Governorate. J. Adv. Agric. Res., 20: 128-137.

Fathey, R., B. Alia and G.R. David (2020). Four records of new to Egypt gastropod species including the first reported tropical leather leaf slug *Laevicaulis alte* (d'a.De férussac, 1822) (Pulmonata: Veronicellidae). Zoology and Ecol., 2165-8005.Https:// doi.org /10. 35513/21658005.2020. 2.8.

Flint, M.L. (2011). Snails and slugs. Uc Ipm online. Http: //www. ipm. ucdavis. edu/pmg/ pestnotes/pn 7427.Html (14 July 2011).

Gaber, O.A., H.M. El-Fayoumi, G. El-Shahawy, F.K. Khider, H. Abdel-Tawab, K. Mahmoud (2022). Influence of methomyl (Copter 90%) on certain biochemical activities and histological structures of land snails *Monacha cartusiana*. Saudi J. Biol. Sci., 29 (4): 2455–2462. https:// doi.org /10.1016 /j. sjbs.2021.12.021.

Garthwaite, D.G. and M.R. Thomas (1996). The use of molluscicides in agriculture and horticulture in Great Britain over the last 30 years. In: British Crop Protection Council (BCPC) Monograph, No. 66. Slugs and Snail Pests in Agriculture. Ed. Henderson, I.H., 39-46. 24-26, Sept.1996 (c.f. Rev. Agric. Entomol., 1997, 85 (4): Abs. 3422).

Geasa, N.S., F.N. Heiba, M.M. Mortada and I.S. Mosbah (2013). Molluscicidial activity of certain biological insecticides against land snails *Monacha cartusiana* and *Succinea oblonga* in laboratory and field conditions. Egy. J. Zool., 60: 179 – 188.

Ghamry, E.M., H.I. El-Deeb and S.M. Abd El-Aal (1993). Efficacy of certain pesticides against some land snails under field conditions of Sharkia Governorate. Egypt. J. Appl. Sci., 8 (6): 764 - 774.

Ghamry, E.M., Y.A. Kokab and B.M. Wilson (1994). Screening test of some insecticides against two land snails, *Monacha contiana* and *Eobania vermiculate* in Sharkia Governorate. Zagazig J. Agric. Res., 21(5): 1539-1545.

Godan, D. (1983). Pest slugs and snails, biology, and control. Spinger-Verlag, Berlin, Heidelberg, 445.

Hammond, R.B., J.A. Smith and T. Beck (1996). Timing of molluscicide applications for reliable control in no-tillage field crops. J. Econ. Entomol., 89: 1028-1032.

Haszprunar, G. (2020). Mollusca (Molluscs). Encyclopedia of Life Sciences (ELS) 1(3): 565–571 doi: 10.1002/9780470015902.a00 29219.

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

Heiba, N.F., M.M. Mortada, S.N. Geassa, A.I. Allam and S.I. Abd El-Wahed (2018). Terrestrial Gastropods: Survey and relationships between land snail assemblage and soil properties. J. Plant Prot. and Pathol., 9 (3): 219 – 224 doi: 10.21608/jppp.2018.41393.

Henderson, G.F. and E.W. Tillton (1955). Test with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.

Howlett, S.A. (2012). Terrestrial slug problems: classical biological control and beyond. CAB International, (Online ISSN 1749-8848) doi: 10.1079/PAVSNNR20127051.

Ibrahim, M.M., M.E. Lokma and M.A. Issa (2017). Economic Threshold, Injury Levels and Food preference of glassy clover snail, *Monacha cartusiana* (Muller) Infesting strawberry plants at Ismailia Governorate, Egypt. Egypt. Acad. J. Biol. Sci., H. Bot., 8 (2):11-20 doi: 10.21608/eajbsh.2017.16763.

Iglesias, J., J. Castillejo and R. Castro (2003). The effects of repeated applications of the molluscicide metaldehyde and the biocontrol nematode *Phasmarhabditis hermaphrodita* on mollusks, earth worms, nematodes, acarids and collembolans: a two- year study in north-west Spain. Pest Manag. Sci., 59: 1217-24.

Ismail, S.A., S.Z.S. Shetaia, A.I. Arafa and A.F. Abdel-Atty (2011). Incidence and seasonal fluctuation of certain land gastropod species associated with some crops and weeds at Sharkia Governorate. J. Plant Prot. and Pathol., 2 (2):1103-1110 doi.10.21608/jppp. 2011.86641.

Ismail, S.A., S.Z.S. Shetaia, A.A.I. Arafa and M.M. Khattab (2014). Field trials on the bait attractive distances and evaluation the efficacy of methomyl using different control application methods against the gastropod pest *Monacha cartusiana* (Muller) infesting clover fields. J. Plant Prot. and Path., Mansoura Univ., 5 (6): 697-703.

Kadry, W.M., A.E. Abd-Elmageed, M.W. Boules and S.M. Bayoumi (2018). Survey and population dynamics of some land snails infesting different plant hosts at Sharkia Governorate. J. Environ. Sci., 42 (1): 107-118 doi.10.21608/jes.2018.21617.

Keith, M.A., H.B. Solveig, R.C. Robbie, Y.D. Jain, C.D. John, H.D. Simona and W.A. Michael (2009). Dispersal patterns and behavior of the nematode *Phasmarhabditis hermaphrodita* in mineral soils and organic

media soil, Biol. and Biochem., 41: 1483 –1490 doi:10.1016 /j. soilbio.2009.04.007.

Mahrous, M.E., A.E. Basha, M.H. Ibrahim, S.A. Ismail and M.H. Lokma (2006). Observation on aestivation, dispersal, and breeding season of the glassy clover snails *Monacha cartusiana* at Sharkia Governorate. J. Agric. Sci. Mansoura Univ., 31 (8): 5487-5497.

Miller, E., S. Swails, D. Swails, F. Oslon and R.T. Stalen (1988). White garden snail *Theba pisana* efficacy of selected bait and sprayable molluscicides. J. Agric. Entomol., 5: 189–197.

Moran, S., Y. Gotlib and B. Yaakov (2004). Management of land snails in cut green ornamentals by copper hydroxide formulations. J. Crop Prot., 23: 647–650.

Mortada, M.M., A.M. Soliman and F.K. Khidr (2005). Molluscicidial activity of certain compounds against *Monacha cartusiana* land snails under laboratory and field conditions. J. Agric. Sci. Mansoura Univ., 30(12): 8147-8151.

Newman, M.C., A. Beeby, R.W. Hurst and L. Richmond (1994). Snail *Helix aspersa*, exposure history and possible adaptation to lead as reflected in shell composition. Archives of the Environ. Contam and Toxicol., 27 (3): 340-351.

Okka, M.A. (2005). Efficacy of some pesticides baits for controlling the land snail *Monacha cantiana*. (Montagu) under field conditions at Kafr El- Sheikh Governorate. J. Agric. Res. Tanta Univ., 31(1): 46-53.

Prakash, A. and J. Rao (1997). Botanical pesticides in agriculture. CRC press, Inc. Lewis publishers, 345- 354.

Radwan, M.A., H.B. El-Wakil and K.A. Osman (1992). Toxicity and biochemical impact of certain oxime carbamate pesticides against terrestrial snail, *Theba pisana* Müller. J. Environ. Sci. and Health, Part B. Pesticides, Food Contaminants and Agric. Wastes., 27 (6): 759-773.

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

Rady, G.H., A.A. Abd Elgawad, S.H.A. Ismail M.H. Lokma (2014). Ecology of some terrestrial molluscs in Sharkia and Ismailia Governorates. Egypt. J. Agric. Res., 92 (3): 907-920 doi.10.21608/ejar.2014.156353.

Sallam, A.A.A., S.A. El-Massry and I.N. Nasr (2009). Chemical analysis of mucus from certain land snails under Egyptian conditions. Archives of Phytopathol. and Plant Prot., 42: 874–881.

Schweizer, M., R. Triebskorn and H.R. Köhler (2019). Snails in the sun: Strategies of terrestrial gastropods to crop with hot and dry conditions. Ecol. and Evolution, 9 (22): 12940-12960. doi.org/10.1002/ece3.5607.

Sean, V.E., A.M. Nelson, P. Renzo and B.A. Janine (2015). Plant selection and grazing activity of the invasive snail *Theba pisana* in coastal Agoa Bay, South Africa. Afr. Zool., 50 (3): 227–231. http://dx.doi.org/ 10.1080/ 15627020.2015.1040838 .

Shah, S. (1992). Management of the giant African snail. Indian Farming, 41 (11): 21. (c.f. Rev. Agric. Entomol., 81 (7): 744).

Speiser, B. and C. Kistler (2002). Field tests with a molluscicide containing iron phosphate. Crop Prot., 21: 389-394.

Staikou, A. and M. Lazaridou-Dimitriadou, (1990). Aspects of the life cycle, population dynamics, growth and secondary production of the snail, *Monacha cartusiana* (Müller, 1884) (Gastropoda: Pulmonata) in Greece. Malacologia, 31(2): 353-362.

Tillier, S., G.V. Jackson and R. Macffarlance (1995). Giant African snail. 2nd Ed. c.f. Rev. Agric. Entomol., 85 (5): 457.

تقدير التأثير الإبادي لبعض المبيدات ضد قوقع البرسيم الزجاجي (Müller) *Monacha cartusiana* في بعض محاصيل الخضر تحت الظروف الحقلية بمحافظة الشرقية، مصر

حمدي احمد عبد الحميد[1] – محمد عبد العال هنداوي[2] – محمد حسن سليمان[1] – السيد محمد عبد العال[2]

1- معهد بحوث وقاية النباتات – مركز البحوث الزراعية – 12311 الدقى – الجيزة – مصر

2- قسم وقاية النبات – كلية الزراعة – جامعة الزقازيق – مصر

تم إجراء مجموعة من التجارب الحقلية باستخدام بعض المبيدات شائعة الاستخدام على محاصيل الخضر بحثاً عن مركب مناسب يمكن استخدامه بنجاح في مكافحة قوقع البرسيم الزجاجي *Monacha cartusiana* وذلك خلال فترة النشاط تحت الظروف الحقلية بمحافظة الشرقية. وأظهرت النتائج التي تم الحصول عليها أن نسبة الانخفاض في التعداد لقوقع البرسيم الزجاجي تحت الظروف الحقلية تختلف معنوياً من مبيد إلى آخر ومن محصول خضر إلى آخر، ويتوقف ذلك بناء علي تاريخ الفحص بعد التطبيق، وكثافة الإصابة والسلوك البيئي للقواقع. حيث اظهرت المبيدات المختبرة انخفاض في تعداد أعداد القواقع في محصول الكوسة بدرجات متفاوتة فقد سجلت المتوسطات العامة لنسبة الانخفاض بعد ثلاثة أيام من التطبيق أقصى انخفاض مع الملاثيون والميثوميل بنسبة 57.26 و53.61%، في حين سجلت أقل التأثيرات مع مركبي إيميداكلوبريد وأسيتامبريد بنسبة 31.25 و 27.07%. ولوحظ نفس التاثير بعد أسبوعين وثلاثة أسابيع من التطبيق مع زيادة أو نقص طفيف في نسب الانخفاض في التعداد مع جميع المركبات المختبرة. وعلى الجانب الآخر أدت المبيدات المختبرة إلى خفض تعداد القوقع في محصول الكرنب بعد أسبوع من التطبيق، حيث بلغ الحد الأقصى لنسب الانخفاض باستخدام الميثوميل والملاثيون 56.09 و52.51%، في حين تم تسجيل أقل التأثيرات باستخدام الأسيتامبريد والإيميداكلوبريد بنسبة 30.61 و26.51% على التوالي. وفيما يتعلق بتقليل أعداد القواقع على الباذنجان بعد ثلاثة أسابيع من الاستخدام، فقد تم تسجيل أعلى تأثير مع الملاثيون، بينما كان التأثير متوسط مع مركب الفبرونيل بينما أظهر الإيميداكلوبريد أقل تأثير في خفض التعداد. أما على الطماطم وبعد أسبوع من التطبيق فقد بلغت نسبة الانخفاض في تعداد القواقع مع الملاثيون 57.25% يليه الميثوميل 53.60% بينما مع إيميداكلوبريد 31.25% وأسيتامبريد 27.07%. وفي حالة التطبيق في محصول البازلاء، فقد اظهرت المبيدات المختبرة اعلي فعالية بعد الأسبوع الثالث من التطبيق بمركب الميثوميل؛ بينما كان التأثير متوسط مع الفبرونيل، في حين سجل أقل تأثير مع إيميداكلوبريد. وفي محصول السبانخ وبعد أسبوع من التطبيق سجلت نسب الإنخفاض 59.24% مع الميثوميل، 55.47% مع الملاثيون، 32.33% مع الأسيتامبريد و28.01% مع الإيميداكلوبريد، كما لوحظ نفس التاثير ايضا بعد أسبوعين وثلاثة أسابيع من التطبيق. وبصفة عامة يمكن ترتيب التاثير الإبادي لبعض المبيدات المختبرة لمكافحة قوقع البرسيم الزجاجي تحت الظروف الحقلية علي محاصيل الخضر بمحافظة الشرقية بعد أربعة أسابيع من التطبيق على النحو التالي: ميثوميل > ملاثيون > إيمامكثين بنزوات > فيبرونيل > أسيتاميبريد وإيميداكلوبريد بنسب خفض في تعداد القوقع مقدارها 59.06 ، 54.24 ، 47.77 ، 43.26 ، 30.75 و 28.96% على التوالي.

الكلمات الإسترشادية: مبيدات الرخويات، محاصيل الخضر، القواقع الأرضية، *Monacha cartusiana*.

المحكمـــون:

1- أ.د. علي عبدالعزيز الشيخ رئيس بحوث بمعهد بحوث وقاية النبات.

2- أ.د. السيد محمود مصطفي أستاذ علم الحيوان الزراعي بكلية الزراعة جامعة الزقازيق.