Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Toxicity Comparison of Certain Compounds Against the Terrestrial Clover Snail, *Monacha cartusiana*: Laboratory and Field Studies

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Abstract

DUE to the importance of *Monacha cartusiana* as a major herbivorous pest, a study was conducted in Kafr El-Sheikh to estimate its population density and damage to sugar beet fields, alongside evaluating pesticides to reduce its spread. Data revealed that the snail population density was lowest in mid-February, with a mean of 9.0 ± 1.41. The population gradually increased from late February to mid-March, reaching a peak density of 148.4 ± 11.16 by the end of March on sugar beet crops. The study observed that *M. cartusiana* snails caused increasing damage to sugar beet leaves, starting with a damaged area of 10.95 ± 0.85 mm² by mid-February. This damage escalated over the following weeks, peaking at 544.11 ± 81.36 mm² by late March, representing 22.57% of the leaf area. However, by mid-April, the damage significantly decreased to 25.40 ± 5.93 mm² due to a reduction in the snail population. The toxicity results indicated that the oxamyl compound was the most toxic, with a LC_{50} value of 0.26% and 495.80 ppm, compared to the rest of the compounds when using the baits and residual film methods under laboratory conditions, while in the field, the oxamyl compound gave the highest mortality rates, followed by Azoxystrobin, Sodium tripolyphosphate and Propiconazole with values of 97.35%, 92.01 and 74.12 and 64.96 after 21 days of treatment, respectively. Also, pathological symptoms clearly appeared in the treated individuals compared to the control.

Keywords: The clover snail, Damage assessment, Azoxystrobin, Propiconazole, Sodium Tripolyphosphate.

Introduction

In many regions of the world, terrestrial molluscs, including slugs and snails, have become severe pests due to their rising importance. They are classified as belonging to the Gastropoda Class [1]. The number of agronomic, horticultural, and ornamental plants infested by terrestrial snails and slugs in Egypt is seriously reducing the plants quality, yield, and marketing value. These are herbivorous animals that target plant parts at various stages of growth, reducing yields [2]. In addition to causing financial loss, these animals also leave their faces and mucus on infected plants, which reduce the overall quality of the plants [3, 4]. The glassy clover snail, *Monacha* sp., is one of the land snail species that infests agricultural crops in Kafr El-Sheikh Governorate [5, 6]. The extensive use of chemical pesticides to control agricultural pests has led to the emergence of pest resistance to these pesticides, which leads to many negative effects on human health and the environment. It is therefore crucial to find new and rational pesticides to increase efficiency and overcome resistance to these pesticides [7, 8, 9]. Azoxystrobin is a systemic fungicide with a broad spectrum that is derived from strobilurins that occur naturally in many species of basidiomycete fungi. Strobilurin fungicides inhibit mitochondrial

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(Received 03 April 2025, accepted 28 May 2025)
DOI: 10.21608/ejvs.2025.368938.2756

respiration, where they would normally bind to Q_O sites of the cytochrome bc1 complex in target fungi [10]. Oxamyl is a carbamate chemical that finds application in several agricultural contexts. As a nematicide [11] or insecticide [12], it is systemic and effective. Propiconazole belongs to triazoles, the mode of action is a demethylation inhibitor, which leads to inhibited ergosterol biosynthesis, that is important for the formation of cell walls [13]. Despite the wide use of chemical control methods, there is a limited understanding of how different modes of action influence molluscicidal effectiveness across varying environmental conditions. In particular, the comparative performance of newer compounds against *Monacha cartusiana* remains underexplored in Egyptian agricultural systems. The objectives of this work were to assess the molluscicidal activity of some new compounds as alternative agents to control the terrestrial snails, *Monacha cartusiana* under laboratory and field conditions.

Material and Methods

In *Population density and damage caused by Monacha cartusiana snails*

This study was carried out under field conditions in an area of one feddan cultivated with sugar beets and heavily infested with the clover snail *Monacha cartusiana*, to study the population density of these animals and estimate the damage they cause to the sugar beet plantations at Manshet Ali village, Sidi Salim district, Kafr El-Sheiekh Governorate during the snail activity season, spring 2024, in the period from 15 February to 15 April. Five replicates were randomly selected, each of which was 1 m^2. The number of individuals on the foliage and the soil surface was recorded, and in addition, three leaves were taken for each sample (1 m^2) and transported to the laboratory weekly to determine the area of the whole leaf and the ingested areas using ImageJ software. The percentage of damage was calculated using the formula reported by El-Deeb et al. [14]. We analyzed the ingested area and population density data using one-way ANOVA and presented the results as mean S.E. using the Costat.exe system software.

Toxicity of certain compounds against Monacha cartusiana

Tested Snails:

For laboratory experiments, we collected adult individuals of the herbivorous land snails *M. cartusiana* from fields cultivated with sugar beet at Manshet Ali village, Sidi Salim district, Kafr El-Sheiekh Governorate, and transferred them to the laboratory in plastic bags. In the laboratory, the snails were kept in a ventilated plastic terrarium filled with moist sandy loamy soil 1:1 by volume, and they were fed with fresh green lettuce leaves (*Lactuca sativa* L.) for acclimatization for 15 days before bioassay experiments. Dead snails were removed immediately [15, 16].

Tested Compounds:

A. Benozed (Propiconazole 25 % EC):
Trade name: Benozed 25 % EC
Active ingredient (Common name): Propiconazole

Molecular formula: C15H17Cl2N3O2
Chemical group: Triazoles

B. Kafrostar (Azoxystrobin 25 % SC):
Trade name: Kafrostar 25 % SC
Active ingredient (Common name): Azoxystrobin

Molecular formula: C22H17N3O5

Chemical group: Methoxyacrylates (derived from strobilurins)

C. Vydate (Oxamyl 24 SL):
Trade name: Vydate 24 % SL
Active ingredient (Common name): Oxamyl

Molecular formula: C7H13N3O3S
Chemical group: Carbamates

D. Earthborn elements (Sodium tripolyphosphate):

Active ingredient (Common name): Sodium tripolyphosphate (STPP)

Molecular formula: Na5P3O10

Inorganic compound (the sodium salt of the polyphosphate penta-anion)

Laboratory evaluations

Laboratory tests were carried out to evaluate the toxicity of certain compounds as molluscicides against *M. cartusiana* using two techniques, baits and residual film, at concentrations of (0.6, 0.9, 1.2, 1.5 and 1.8%) and (1000, 1500, 2000, 2500 and 3000 ppm) for propiconazole, (0.5, 1, 1.5, 2 and 2.5%) and (500, 1000, 1250, 1500 and 1750 ppm) for azoxystrobin, (0.2, 0.5, 0.7, 1 and 1.3%) and (250, 500, 750, 1000 and 1250 ppm) for oxamyl, (0.2, 0.5, 1, 1.5 and 1.8%) and (1125, 2500, 3750, 7500 and 10000 ppm) for sodium tripolyphosphate.

Poisonous baits test

The prepared concentrations of the tested compounds were mixed with 5 g of sugarcane syrup as an attractant. The mixture was then completed with wheat bran to reach a total weight of 100 g and moistened with small amounts of water to formulate poisonous baits. The control treatment was prepared without adding poisonous baits. Five grams of bait were introduced to snails in each box filled with moist soil. Five individual adult snails were used in three boxes for each treatment, and then covered with muslin clothes netting and secured with a rubber band to prevent snails from escaping. The tested boxes were checked daily for 7 days to record and remove dead animals. Mortality percentages were estimated and corrected according to Abbott's formula [17]. The slope, LC_{50} values were calculated as described by Finney [18] using the "LdP Line"® software.

Residual film test

Toxicity effects were performed using the contact technique (residual film) according to the method of Asher and Mirian [19]. To achieve the required concentrations, we diluted the tested compounds with distilled water. Two ml of each concentration was spread on the bottom of the Petri dish by moving the dish gently in circles. Water evaporated under room temperature in a few minutes, leaving a thin film of the tested compound on the surface of the Petri dish. For each treatment, 15 individuals were used and put in three plastic boxes (five snails for each replicate). The control treatment was carried out using distilled water. Numbers of deaths were recorded daily for seven days of treatment, and percentages of mortality were determined and corrected according to Abbott's formula [17], in addition to estimating the LC_{50} values of the investigated compounds.

Field evaluations

A field experiment was carried out in a sugar beet field heavily infested with the land snail *M. cartusiana* at Manshet Ali village, Sidi Salem district, Kafr El-Sheikh Governorate, during April 2024. The tested materials in the laboratory were applied to the infested area, which was divided into plots, with concentrations of 1.3%, 1.8%, 1.8 and 2% for oxamyl, propiconazole, sodium tripolyphosphate, and azoxystrobin, respectively. These concentrations were prepared by incorporating the calculated weight of the tested compound with wheat bran as a carrier substance (w/w), adding sugarcane syrup (5%) as an attractant and applied it as poison bait. The baits were changed every week. Each plot, including the control, covered an area of approximately 175 m^2. The number of live snails within each plot was recorded before treatment and at 1, 3, 7, 10, 15, and 21 days after application. The reduction percentages were statistically determined by utilizing the Henderson and Tillton [20] formula, as described by Abdel-Rahman et al. [21].

Results

Population density and damage estimation of Monacha cartusiana snails under field conditions

The results of population density and the damage assessment of the terrestrial snail *Monacha cartusiana* on sugar beet crop fields in Kafr El-Sheikh Governorate during the period from February 15 to April 15, 2024, are presented in Table 1. The data showed that the lowest snail population densities were observed in mid-February, with a mean value of 9.0 ± 1.41. The population gradually increased on February 23, followed by further rises from March 1 to 15, with mean values of 31.4 ± 6.02, 69.2 ± 8.36, and 107.6 ± 19.07, respectively. The highest densities were recorded on sugar beet crops at the end of March, reaching a value of 148.4 ± 11.16. On the other hand, *M. cartusiana* snails caused considerable damage to sugar beet leaves by February 15, with the damaged area measuring 10.95 ± 0.85 mm² and a damage percentage of 1.42%. The damaged area increased over the next two weeks, reaching 155.16 ± 53.04 mm² at the beginning of March. By March 23, the ingested area reached 544.11 ± 81.36 mm², with the damage percentage peaking at 22.57%. However, by mid-April, the damage to leaf area had decreased significantly due to a decline in the snail population, with the damaged area reduced to 25.40 ± 5.93 mm2. Thus, the results indicate a positive correlation between snail density and damage to sugar beet leaves.

Toxicity of certain compounds against the land snail, Monacha cartusiana using two techniques under laboratory conditions

The molluscicidal activity of azoxystrobin, propiconazole, sodium tripolyphosphate compared to oxamyl compound as a reference compound against the terrestrial snail *M. cartusiana* using poison bait techniques under laboratory conditions is portrayed in Table 1 and Figure 1. It was found that oxamyl exhibited the most toxic effects, followed by sodium tripolyphosphate and Azoxystrobin, with LC_{50} values of 0.26 %, 0.43 %, and 0.64 %, with toxicity index and relative potency (100%, 60.82% and 41.26%) and (3.38, 2.04 and 1.37), respectively. While propiconazole gave the least toxic effects with LC_{50} values of 0.88% and toxicity index and relative potency of 30.16% and 1, respectively.

On the other hand, the toxicity of azoxystrobin, propiconazole, sodium tripolyphosphate and oxamyl against *M. cartusiana* using the residual film technique was illustrated in Table 3 and Fig. 2. Data demonstrated that oxamyl shows the highest toxicity, followed by azoxystrobin and propiconazole. The estimated LC_{50} values were 495.80 ppm, 637.20 ppm, and 1246.42 ppm, with a toxicity index and relative potency of (100%, 77.80% and 39.77%) and (3.14, 2.44 and 1.25), respectively. However, snail mortality after each treatment increased with increasing concentration, while the lowest toxicity was recorded for sodium tripolyphosphate compound, with a LC_{50} value, toxicity index and relative potency of 1558.53 ppm, 31.81% and 1, respectively.

The pathological features of the terrestrial snail *Monacha cartusiana* exposed to the tested compounds, compared to the untreated snails, are illustrated in Fig. 3. The pathological effects in snails treated with were first observed as relaxation of the foot towards the treated surface, followed by a gradual slowing of movement and eventual paralysis of the foot. Concurrently, mucous secretions appeared, leading to a change in body color to brown, and ultimately, the snails died. With increasing exposure time, the outer shell of some treated snails became damaged, possibly due to the emergence of cannibalism.

Toxicity tests under field conditions

Data in Table (4) and Fig. (4) revealed that the effect of the tested pesticides in reducing populations of *M. cartusiana* snails exhibited varying degrees of percent reduction compared to the control. Where the population density reduction after 3 days of these materials were (33.04, 36.75%, 42.7% and 45.01%) reduction for azoxystrobin, propiconazole, sodium tripolyphosphate and oxamyl, respectively. The same trend was observed after 10 days since, oxamyl gave the highest reduction percentage of 73.24%, followed by azoxystrobin, sodium tripolyphosphate and propiconazole with reduction percentages of 65.7%, 56.98% and 53.27%, respectively. While the reduction rates reached their maximum after 21 days, with values of 64.96%, 74.12%, 92.01% and 97.35% for propiconazole, sodium tripolyphosphate, azoxystrobin and oxamyl, respectively. Regarding the general mean reduction percentages of these materials, they were (47.61%, 53.29%, 57.14% and 64.34%) for the same precursor compounds, respectively.

Discussion

The results of the current study showed that the land snail *Monacha cartusiana* causes significant damage to sugar beet fields under field conditions due to its increased snail population, especially in the active season during suitable climatic conditions. Our results are consistent with the study conducted by Shalaby et al. [22], who found that the population density of *Monacha* snails reached its maximum on the sugar beet crop during the spring months at the end of the 2005/2006 growing season with population densities of (26, 51 and 62) and (26.66.2 and 60) individuals/m2 for three plantations in two districts, Kafr El-Sheikh and El-Hamol, respectively. While during the 2006/2007 season it was (29.2, 22 and 70) and (29.6, 30.4 and 76.5) individuals/m2 in the same districts, respectively. They also pointed out that the rates of damage and loss increase with the level of snail infestation on the plant, as at an infestation level of 50 individuals/m^2, the general mean of reduction to foliage, root weight and sugar yield were (23.44, 3.46 and 12.23) during the 2006/2007 season. Shahawy *et al.* [6] reported that *M. cantiana* snails caused a 2.38% reduction in lettuce leaf area on March 15, increasing to 2.95% after two weeks and peaking at 4.81% in mid-April. By the end of April, the reduction decreased to 1.17% due to a decline in the snail population. On the other hand, our results summarized that the oxamyl compound showed the highest activity against the harmful terrestrial snail *M. obstructa* under laboratory and field conditions, followed by the compounds azoxystrobin, sodium tripolyphosphate and propiconazole. Therefore, these compounds can be considered in integrated land snail control programs in infested fields. The results of the bioassay showed a high activity of methomyl and oxamyl compared to the rest of the tested pesticides against *Eobania vermiculata* at all different exposure times, with lC_{50} values of (0.259, 0.358), (0.058, 0.90), (0.024, 0.023) and (0.024, 0.004), after 24, 48, 72 and 96 hrs, respectively [23]. Furthermore, the data supports Gadalah's [24] findings that carbamates (methomyl and oxamyl) were the most potent compounds, followed by neonicotinoid (acetamiprid). Under field conditions during three different seasons, Ismail et al. [25] indicated that oxamyl gave the highest reduction rates of *M. cartusiana* snails, followed by methomyl, while dimethoate noticed the lowest one. According to the results presented by Radwan et al. [26], the compound azoxystrobin induced physiological and biochemical disturbances and histopathological changes in the land snail *Theba pisana.* Propiconazole is an effective fungicide that has proven its toxicity against insect pests, for example, *Spodoptera litura*, as it was highly toxic against cells and larvae of *S. litura* [27].

Conclusion

Integrated land snail management programs often include chemical pesticides to enhance crop protection, especially when population densities are high, to reduce their distribution. Thus, our results concluded that the oxamyl compound, followed by the azoxystrobin, sodium tripolyphosphate and propiconazole compounds, showed effectiveness against the targeted snail *Monacha cartusiana*, after studying their population density and their serious damage to sugar beet fields in Kafr El-Sheikh Governorate.

Acknowledgments

This work was supported by the Faculty of Agriculture, Al-Azhar University and Agricultural Research Center, Plant Protection Research Institute, Giza, Egypt.

Funding statement

This study didn't receive any funding support

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

TABLE 1. Population density and damage of *Monacha cartusiana* snails on sugar beet fields at Manshet ali village, Sidi Salim district, Kafr El-Sheikh Governorate during the activity period

Investigation date	The ingested area $(mm^2)/m^2$ (Mean ± SE)	% Damage	Number of snails/m^2 (Mean ± SE)	Air Temp.		Average of R.H.%
				Max.	Min.	
15 – Feb.	10.95 ± 0.85^{c}	1.42	9.0 ± 1.41^{e}	18.2	11.8	80.0
23 – Feb.	24.39 ± 4.35^{c}	1.66	31.4 ± 6.02^{de}	19.5	14.2	80.5
1 - Mar.	155.16 ± 53.04^{bc}	5.67	69.2 ± 8.36^{c}	28.8	14.5	72.0
8 - Mar.	271.01 ± 79.52^{b}	9.59	156.0 ± 5.42^{a}	21.0	11.4	77.5
15 - Mar.	253.33 ± 47.82b	12.64	107.6 ± 19.07^{b}	23.9	12.0	73.0
23 - Mar.	544.11 ± 81.36^{a}	22.57	148.4 ± 11.16^{a}	20.7	13.3	67.0
1 - Apr.	24.53 ± 11.98^{c}	0.77	45.2 ± 6.62^{cd}	29.4	20.2	72.0
8 – Apr.	17.88 ± 4.74^{c}	0.68	18.8 ± 4.63^{de}	17.6	18.3	88.5
15 – Apr.	25.40 ± 5.93^{c}	1.36	14.6 ± 2.24^{e}	29.6	20.6	66.5

*Means within a column followed by the same letter are not significant different ($P > 0.05$).

TABLE 2. Efficiency of certain compounds against the terrestrial snail, *Monacha cartusiana* using poison baits techniques under laboratory conditions

Compounds	LC_{50} (%)	Slope &Variance	Toxicity Index (%)	Relative Potency
Kafrostar (Azoxystrobin)	0.64	2.37 ± 0.72	41.26	1.37
Benozed (Propiconazole)	0.88	2.71 ± 0.91	30.16	1
Sodium tripolyphosphate	0.43	1.26 ± 0.43	60.82	2.04
Vydate (Oxamyl)	0.26	1.63 ± 0.55	100.00	3.38

*Toxicity index compared with oxamyl compound
Relative potency compared with propiconazole compound

TABLE 3. Efficiency of certain compounds against the terrestrial snail, *Monacha cartusiana* using residual film technique under laboratory conditions

Compounds	LC_{50} (ppm)	Slope &Variance	Toxicity Index (%)	Relative Potency
Kafrostar (Azoxystrobin)	637.20	2.73 ± 0.32	77.80	2.44
Benozed (Propiconazole)	1246.42	3.01 ± 0.36	39.77	1.25
Sodium tripolyphosphate	1558.53	1.46 ± 0.18	31.81	1
Vydate (Oxamyl)	495.80	2.47 ± 0.25	100.00	3.14

*Toxicity index compared with oxamyl compound
Relative potency compared with Sodium tripolyphosphate compound

TABLE 4. Reduction ratios of *Monacha cartusiana* snails after using the tested toxicants as poison baits under field conditions at Sidi Salem district, Kafr El-Sheikh governorate

Treatments	(%) Reduction after treatment/ Days						General mean
	1-day	3-days	7-days	10-days	15 -days	21-days	
Kafrostar (Azoxystrobin)	15.12	33.04	54.01	65.7	82.96	92.01	57.14
Benozed (Propiconazole)	20.61	36.75	48.45	53.27	61.61	64.96	47.61
Sodium tripolyphosphate	25.09	42.7	52.32	56.98	68.52	74.12	53.29
Vydate (Oxamyl)	25.28	45.01	60.65	73.24	84.51	97.35	64.34
Mean	21.53	39.38	53.86	62.30	74.40	82.11	

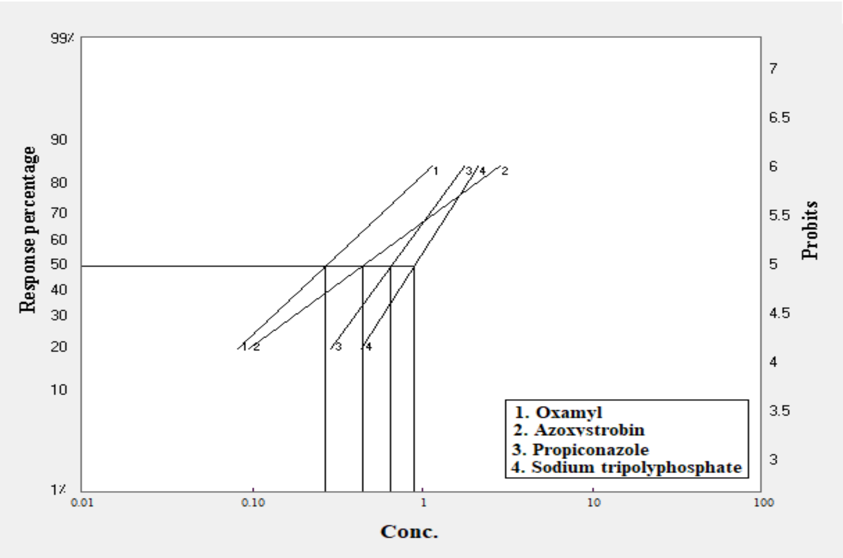

Fig. 1. Toxicity of certain compounds against the terrestrial snail, *Monacha cartusiana* using baits technique under laboratory conditions

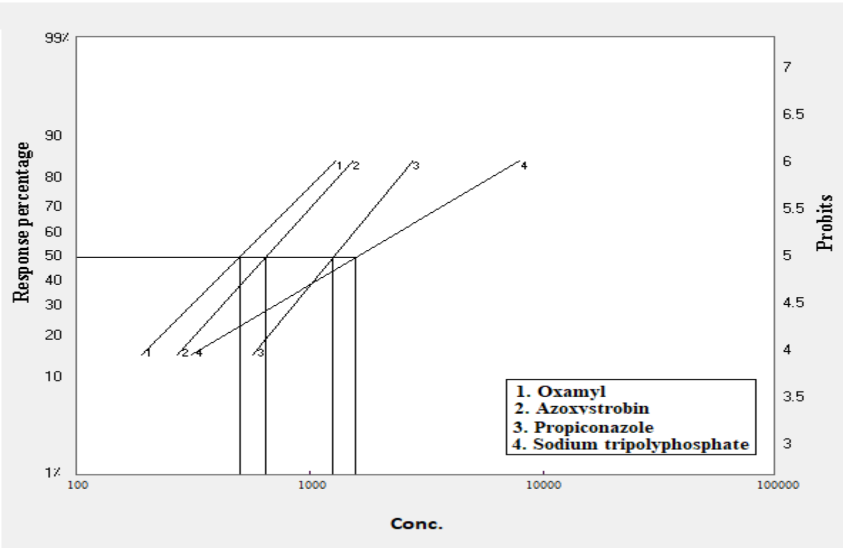

Fig. 2. Toxicity of certain compounds against the terrestrial snail, *M. cartusiana* using the residual film technique under laboratory conditions

Fig.3. Phenotypic features of treated and untreated *Monacha cartusiana* snails: a) treated snails, b) untreated snails

References

1. Monte, T.C.C., Simões, R.O., Oliveira, A.P.M., Novaes, C.F., Thiengo, S.C., Silva, A.J., Estrela, P.C. and Júnior, A.M., Phylogenetic relationship of the Brazilian isolates of the rat lungworm *Angiostrongylus cantonensis* (Nematoda: Metastrongylidae) employing mitochondrial COI gene sequence data. *Parasites & Vectors*, **5**,248 (2012). https://doi.org/10.1186/1756-3305-5-248

2. Khidr, F.K., Abo–Hashem, A.A.M., Keshta, T.M.S. and Ismail, S., Some of biochemical changes induced by Theophylline and Furosemide in the land snail, *Monacha obstructa. J. Plant Prot. and Path.,* **2**(4), 429-437 (2011).

3. Iglesias, J., Jose, C. and Castro, R., The effects of reported applications of the molluscicide metaldehyde and biocontrol nematodes *Phasmarhabditis hermaphrodita* on molluscs, earthworm, nematodes, acarids and collembolans: a two year study in North West spain. *Pest Management Science*, **59**,1217-1224 (2003). https://doi.org/10.1002/ps.758

4. Heiba, F.N., Mortada, M.M., Geassa, S.N., Atlam, A. and Abd El-Wahed, S.I., Terrestrial gastropods: Survey and relationships between land snail assemblage and soil properties. *J. Plant Prot. and Path*., **9**(3), 219-224 (2018).

5. Gabr, W.M., Youssef, A.S. and Khidr, F.K., Molluscicidal effect of certain compound against two land snail species, *Monacha obstructa* and *Eobania vermiculata* under laboratory and field conditions. *Egyptian Journal Agricultural Research*, **4**, 43-50 (2006).

6. Shahawy, W.A., Mostafa, N.M. and El-Tahawe, H.S., Population density, food consumption and damage caused by the land snail *Monacha cantiana* to some vegetable crops at Kafr El-Sheikh Governorate. *Journal of Plant Protection and Pathology*, **9**(9), 601-604 (2018).

7. Abeed, A.A.O., El-Emary, T.I., Youssef, M.S.K., Hefzy, I. and Ibrahim, H.A.M., Novel synthesis of some heterocycles and their molluscicidal activity against the destructive land snail, *Theba pisana*. *Chemical and Biological Technologies in Agriculture*, **11**(1),602 (2024). https://doi.org/10.1186/s40538-024-00602-z

8. Abd El-Wahed, S.I.M. and Ibrahim, H.A.M., Molluscicidal assessment of certain toxicants: Impact on biochemical alterations and electrophoretic protein patterns in *Massylaea vermiculata* (O. F. Müller, 1774) snails. *Environmental Toxicology and Pharmacology*, **113**, 104619 (2025). https://doi.org/10.1016/j.etap.2024.104619

9. Hussein, M.A. and Sabry, K.H., Assessment of some new pesticides as molluscicides against the adult and eggs of chocolate banded snail, *Eobania Vermiculata*. *Bull NRC,* **43**(75), 1–5 (2019). https://doi.org/10.1186/s42269-019-0118-6

10. Esser, L., Yu, C.A. and Xia, D., Structural basis of resistance to anti-cytochrome bc(1) complex inhibitors: implication for drugimprovement. *Curr. Pharm. Des*., **20**(5), 704–724 (2014). https://doi.org/10.2174/138161282005140214163327

11. Ali, A.A. and El-Ashry, R.M., Potential effect of the nematicide oxamyl and surfactant combinations on root-knot nematode Meloidogyne incognita infecting tomato plants. *Egyptian Academic Journal of Biological Sciences, F. Toxicology & Pest Control*, **13**(1), 159-176 (2021).

12. Alhewairini, S.S., Laboratory and field evaluation of the toxicity of oxamyl against the red palm weevil, *Rhynchophorus ferrugineus* (Olivier). *Pakistan J. Zool.*, **50**, 249-256 (2018).

13. Yastrub, A.M., Comparative toxicological and hygienic assessment and combined action of modern fungicides based on azoxystrobin, pydiflumetofen, propiconazole. *Reports of Vinnytsia National Medical University*, **26**(4), 618-623 (2022). https://doi.org/10.31393/reports-vnmedical-2022-26(4)-17

14. El-Deeb, H.I., Asran, A.A., Kuehnert, G. and ElHalafawy, M.A., Preharvest damage and active burrows of rats in wheat fields. *Agric. Res. Rev., Cairo.*, **28**, 229-233 (1990).

15. Eshra, E.H., Toxicity of methomyl, copper hydroxide and urea fertilizer on some land snails. *Annals of Agricultural Science*, **59**(2), 281–284 (2014).
16. Ibrahim, H.A.M., El-Mesalamy, A.F., Baghdadi, S.A. and Elhanbaly, R., Histopathological effects of methomyl and crude extracts of *Jatropha curcas* against the terrestrial snail, *Monacha obstructa* (Gastropoda: Hygromiidae). *Chemical and Biological Technologies in Agriculture*, **9**(1), 330-2 (2022). https://doi.org/10.1186/s40538-022-00330-2
17. Abbott, W.S., A method of computing the effectiveness of an insecticide. *J. Econ. Entomol*., **18** (2), 265-267 (1925). https://doi.org/10.1093/jee/18.2.265a
18. Finney, D.J., Probit analysis, 3rd ed. Cambridge University Press, London, 318 pp (1971).
19. Asher, R.S. and Mirian, F., The residual contact toxicity of Bay Sir 8514 to *Spodoptera littoralis* larva. *Phytoparasitica*, **9**(2), 133-137 (1981). https://doi.org/10.1007/bf03158455
20. Henderson, C.F. and Tillton, E.W., Tests with acaricides against the brown wheat mite. *J. Econ. Entomol*., **48**(2), 157 – 161 (1955). https://doi.org/10.1093/jee/48.2.157
21. Abdel-Rahman, A.H., El-Massry, S. and Rizk, A., Laboratory and field evaluation of certain chemicals comparing with methomyl against land snail *Monacha* sp. (Stylommatophora: Hygromiidae) infesting Egyptian clover plant. *Egyptian Journal of Plant Protection Research Institute*, **2** (2), 398-404 (2019).
22. Shalaby, G., Mortada, M.M. and Soliman, A.M., Land snails attacking sugar beet fields: i-population density, damage and losses caused by *Monacha cantiana* snails at Kafr El-Sheikh governorate. *Journal of Plant Protection and Pathology*, **32**(4), 3179-3183 (2007).
23. Shaker, N., Badawy, M.E. and Hussein, A.M., Snail control with different and unspecific pesticides. *Journal of Plant Protection and Pathology*, **6**(12), 1653-1661 (2015).
24. Gadalah, H.S., Efficiency of some biological and chemical compounds and their combinations for control some land snails. Thesis submitted for the degree of Doctor of Philosophy in science (Microbiology). Botany department, Faculty of science, Benha University (2013).
25. Ismail, S.A., Shetaia, S.Z.S. and Khattab, M.M., Time of application as main factor affecting the efficacy of certain pesticides against land snail *Monacha cartusiana* (Muller) under filed conditions at Sharkia Governorate. *J. Plant Prot. and Path*., **6**(5), 853-858 (2015).
26. Radwan, M.A., Gad, A.F., Abd El-Aziz, A.M. and El-Gendy, K.S., Unveiling the ecotoxicological effects of azoxystrobin-based fungicides at realistic concentrations on the land snail, *Theba pisana*. *Scientific Reports*, **14**(1), 16427 (2024). https://doi.org/10.1038/s41598-024-66416-z
27. Haizhen, Z., Zhixiang, Z., Meide, L., Jingli, Z. and Hanhong, X., Insecticidal activities of propiconazole against *Spodoptera litura* (Lepidoptera: Noctuidae). *Acta Entomologica Sinica*, **49**(2), 265-270 (2006). https://doi.org/10.16380/j.kcxb.2006.49.2.265270

مقارنة سمية بعض المركبات ضد حلزون البرسيم الأرضي *Monacha cartusiana*: دراسات معملية وحقلية

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الملخص

نظرًا لأهمية الحلزون الأرضى *Monacha cartusiana* كآفة عشبية هامة، تم إجراء دراسة حقلية في محافظة كفر الشيخ لتقدير كثافته العددية وحجم الضرر الذي يسببه لمحاصيل بنجر السكر. بالإضافة إلى ذلك، تم تنفيذ دراسات معملية وحقلية لتقييم فعالية بعض المبيدات في الحد من انتشار هذه الآفة. كشفت البيانات أن كثافة الحلزون كانت في أدنى مستوياتها في منتصف فبراير، حيث بلغت 9.0 ± 1.41 في المتوسط. ثم بدأت الكثافة العددية في الارتفاع تدريجيًا من أواخر فبراير حتى منتصف مارس، لتصل إلى ذروتها عند 148.4 ± 11.16 بحلول نهاية مارس في حقول بنجر السكر. وأظهرت الدراسة أن الحلزون *M. cartusiana* تسبب في أضرار متزايدة لأوراق بنجر السكر، حيث بدأ الضرر بمساحة 10.95 ± 0.85 مم² في منتصف فبراير، وارتفع بشكل تدريجي خلال الأسابيع التالية ليصل إلى 544.11 ± 81.36 مم² بحلول نهاية مارس، ما يمثل 22.57% من مساحة الورقة. ومع ذلك، انخفض الضرر بشكل ملحوظ إلى 25.40 ± 5.93 مم² بحلول منتصف أبريل، نتيجة لانخفاض أعداد الحلزون. أظهرت نتائج اختبارات السُمية أن مركب الأوكساميل (*Oxamyl*) كان الأكثر سمية، حيث بلغ تركيزه المميت الوسطي (LC_{50}) نسبة 0.26% أو 495.80 جزءًا في المليون، مقارنة ببقية المركبات عند استخدام طريقتي الطعم والفيلم المتبقي في الظروف المعملية. أما في الحقل، فقد حقق الأوكساميل أعلى معدل وفيات بين الحلزونات، تلاه مركب الأزوكسي ستروبين (*Azoxystrobin*)، ثم ثلاثي فوسفات الصوديوم (*Sodium tripolyphosphate*)، وأخيرًا البروبكونازول (*Propiconazole*)، بمعدلات وفيات بلغت 97.35%، و92.01%، و74.12%، و64.96% على التوالي، وذلك بعد 21 يومًا من المعاملة. كما لوحظت أعراض مرضية واضحة في الأفراد المعالجة مقارنة بالمجموعة الضابطة(كنترول).

الكلمات الدالة: حلزون البرسيم، تقييم الضرر، أزوكسي ستروبين، بروبيكونازول، ثلاثي فوسفات الصوديوم.