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Comparative Study on the Effect of Biofertilizers and Pesticides on Growth and Yield of Lettuce Crop and Associated Snails

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ABSTRACT

Field experiments were carried out during the two growing seasons of 2022/2023 and 2023/2024 at a private farm in Shiba, Zagazig District, Sharkia Governorate, Egypt. These experiments aimed to study the effect of GA_3, seaweed extract, biofertilizers and biopesticides comparing to pesticides on growth, chemical content and yield of lettuce plants and associated snails that overcome or decrease of them in lettuce plants.

The experiment included 7 treatments as follows:

Control (without any addition)

2- Gastrotox: **(Pesticide)** Chemical name: Metaldehyde 5%

3-Biocyina WP 2.5% (Biocide)

(*Beauveria bassiana*) Used with concentrations**:** 2.5, 5, 15 %

Biometa WP 2.5% (Biocide)

(*Metarhizium anisopliae*) Used with concentrations**:** 2.5, 5, 15 %

Protecto WP 9.4 % (Biofertilizer)

(*Bacillus thuringiensis*, subsp Kurstaki) Used with concentrations**:** 2, 4, 10 %

6-Gabbrellic Acid (GA3),Molecular Formula: $C_{19}H_{22}O_6$

Used with concentrations**:** 5, 10, 20 %

7- Seaweed extract. (Alge fertilizer Potassium Alginate 20% - marine Alge, Molecular Formula: $(C_6H_7KO_6)n$,Used with concentrations**:** 5, 10, 20 %

A randomized complete Block design (RCBD) with three replicates was followed in this study, which involved the treatments above men tined.

All the treatments were applied as foliar spray.

This study included two parts the first part on was some growth characters, and yield of lettuce plants, while the second part was the ecological studies on certain land snails attacked different vegetable crops at Sharkia Governorate.

The results revealed that GA_3, being the most effective vegetative growth characters and yield of lettuce plants, followed by the treatments of seaweed extract, biopesticides, biofertilizers and control pesticides, respectively.

As well as, three species of land snails belonging to three families of order Stylommatophora found on different crops. These species were *M. cartusiana* (Hygromiidae), *E. vermiculata* (Helicidae) and *S. putris* (Succineidae) .The identified species varied in their incidence and level of infestation according to locality and host type. It was obvious that *M. cartusiana* snail has the superior incidence comparing with the other species in all surveyed localities.

The effect of six chemical compounds: Gastrotox 5%, biocyna, biometa, protecto, Alge and GA3 were tested against *M. cartusiana snails* as poison baits under laboratory. where all tested compounds failed to exhibit any molluscicidal activity one-day post treatment. Mortality percentages increased by increasing concentration and exposure periods.

As time elapsed, mortality percentages were increasing where it reached (100, 36.7, 30, 26.7 and 16.6 %) of Gastrotox, Alge, biometa, biocyna, protecto and, after 28-day post treatment, respectively. As for GA3, did not gave any molluscicidal activity at concentration 10% throughout the experiment period.

Determination of LC_{50} After 7 days of treatment for the tested biocide was the height one Biometa and the lower one GA3 compared with the LC_{50} after 3 days of treatment for the tested molluscicide.

Conclusion: The results indicate that the tested compounds differed markedly in their molluscicidal efficiency, with Gastrotox showing rapid, concentration- and time-dependent mortality that reached 100% within 14 days, reflecting strong acute and cumulative toxicity,

Key words: GA3- seaweed extract- chemical compounds against snails- lettuce.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is an annual plant of Asteraceae family. It is self-Pollinated annual plants. It is a vital food vegetable and is especially valuable in terms of vitamin content, minerals and other properties. It also possesses various health benefits; it has inflammatory properties, protects neuronal cells. Growth, yield and quality of lettuce can be affected by various factors such as hormones (GA_3), seaweed extract, biofertilizers, biopesticides and pesticides.

Gibberellins play an important role in inducing anthesis during the vegetative growth stage in many species including leafy vegetables such as lettuce, it is an important in increasing vegetative growth and yield **(Fukuda *et al*., 2012)**.

Seaweed extracts are defined as bio-stimulants derived from non-blooming marine algae that have not true leaves, shoots and foliage. These extracts are common in containing a high content of sterols, polysaccharides, containing compounds (betaines), numerous nourishing elements and several plant growths promoting substances like auxins, Cytokinins, Gibberellins **(Craigie, 2011)**.

The microorganisms which contain plant growth promoting rhizobacteria (PGPR) providing a sustainable approach to increase crop production. PGPR affects plant growth and development, directly or indirectly, either by facilitating nutrient uptake by plants (N_2 Fixation, P solubilization), inducing increases in root surface (hormone production), or reducing the harmful effect of pathogens **(Arora *et al*., 2013)**.

Pesticides and insecticides are used extensively on lettuce grown in many countries in the world, that may reduce lettuce photosynthesis, growth and yield **(Haile *et al*., 2000)**.

Chemical control techniques are still often used to manage land snails (*Monacha* sp.) Even Though there may be unexpected consequences for humans and other creatures the employment of pest control methods obtained from natural sources pesticides and the development of resistance to then **(Massoud and Habib 2003)** the use of synthetic pesticides is a snails in the pest but it is on the targets pests and human heath ecological

system through increasing the environmental pollution 7.8 moreover in the numbers of natural enemies which have effective roles in biological management **(Hussein and Sabry 2019 and Rana *et al*., 2021)**

Some natural compounds and biocides were found to have mollucicidal effects on land snails. If compared with pesticides, Vertimec biocide was proved to have effective toxicity **(El-akhrasy 2017)**. Hence, there was a trend to use natural compounds and biocides instead of chemical pesticides **(Ismail and Mohamed, 2009)**.

Considering the facts, the present study was aimed to find out the GA_3, seaweed extracts, biofertilizers, biopesticides and pesticides, as well as the survey of snails and how to overcome or decrease them on lettuce plants.

MATERIALS AND METHODS

1- Lettuce Plants parameters

1-1 Vegetative growth characters:

Field experiments were carried out during the two growing seasons of 2022/2023 and 2023/2024 at a private farm in Shiba, Zagazig District, Sharkia Governorate, Egypt. These experiments aimed to study the effect of GA_3, seaweed extract, biofertilizers and biopesticides comparing to pesticides on growth, chemical content and yield of lettuce plants and associated snails that overcome or decrease of them in lettuce plants.

The plants were irrigated with surface irrigation system. Seedlings were transplanted after two leaves were completely expanded 30 days after sowing. The cv Dark Green seeds of lettuce were obtained from Vegetable Research Section, Horticulture Research Institute, Agriculture Research center, Giza, Egypt. The seedlings were set up in the field on 3rd and 5th of November in the first and second seasons, respectively. Seedlings were planted on one side of ridges 25 cm apart; ridges were 70 cm in width and 4 m length. Each plot included 4 rides, and the plot area was 11.2 m^2.

The physiological and chemical analysis of experimental field of the soil are shown in Table 1 according to **Black (1965)**.

Table (1): The physical and chemical properties of the experimental soil.

Content	Value	
	2022/2023	2023/2024
Physical properties:		
Sand (%)	85.77	86.69
Silt (%)	6.75	5.89
Clay (%)	7.58	7.42
Soil texture	Sandy	Sandy
Chemical properties:		
Organic matter (%)	0.04	0.06
Available P (ppm)	5.3	5.7
Available K (ppm)	5.8	6.3
Calcium carbonate (%)	53	61
Ph	7.9	8.1

The recommended agricultural practices of growing lettuce plants were applied. All plots received equal amounts of mineral N, P, and K fertilizers at 50, 100 and 50 kg/fed., respectively in the form of ammonium

sulphate (20.5% N), Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% P_2O), respectively. Phosphorus was added during the preparation of the soil, while nitrogen and potassium were added into three portions every 15 days after transplanting the seedlings (15, 30 and 45 days).

The experiment included 7 treatments as follows:

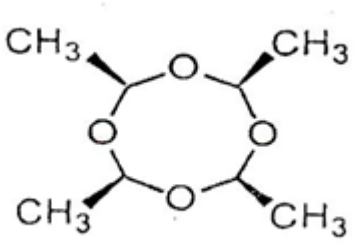
1- Control (without any addition)

2- Gastrotox: **(Pesticide)**

Chemical name: Metaldehyde 5%

Chemical formula: C8H16O4

- **Structure:**



IUPAC name: r-2, c-4, c-6, c-8-tetramethyl- 1,3,5,7- tetroxocane; 2,4,6,8-tetramethyl- 1,3,5,7- tetraoxacyclo-octane.

Used with concentrations**:** 1, 2, 3 %

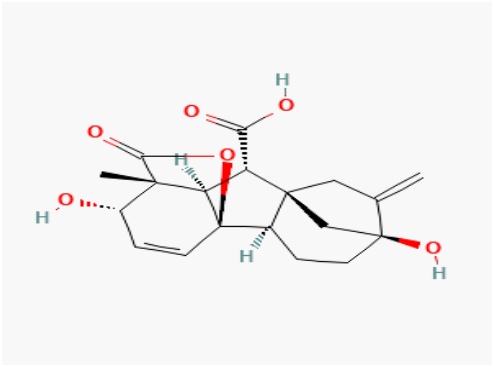
3-Biocyina WP 2.5% (Biocide)

(*Beauveria bassiana*) Used with concentrations**:** 2.5, 5, 15 %

4- Biometa WP 2.5% (Biocide)
(*Metarhizium anisopliae*) Used with concentrations**:** 2.5, 5, 15 %
5- Protecto WP 9.4 % (Biofertilizer)
(*Bacillus thuringiensis*, subsp Kurstaki) Used with concentrations**:** 2, 4, 10 %

6-Gabbrellic Acid (GA3),

Molecular Formula: $C_{19}H_{22}O_6$



Used with concentrations**:** 5, 10, 20 %

7- Seaweed extract. (Alge fertilizer Potassium Alginate 20% - marine Alge, Molecular Formula: $(C_6H_7KO_6)n$

Used with concentrations**:** 5, 10, 20 %

A randomized complete Block design (RCBD) with three replicates was followed in this study, which involved the treatments above men tined.

All the treatments were applied as foliar spray.

This study included two parts the first part on was some growth characters, and yield of lettuce plants, while the second part was the ecological studies on certain land snails attacked different vegetable crops at Sharkia Governorate.

The first part:

Data recorded as follows:

These data recorded as average both growing seasons.

A- Vegetative growth characters:

At 55 days after transplanting, data were recorded: plant height (cm), number of leaves, plant fresh weight and plant dry weight (g).

B-Head yield attributes at 65 days from transplant in the data recorded as follows:
Leaf length (cm), leaf width, leaf area (cm^2), head fresh weight and head dry weight (g).

Statistical analysis:

Statistically significant variations between means were compared at $P \leq 0.05$ by least significant difference (LSD) according to **Snedecor and Cochran (1980)**. The statistical analysis was done by SAS computer software **(SAS Institute, 2004)**.

Part Two:

Laboratory and field experiments had been conducted to obtain basic information concerning ecology, biology and toxicity of the tested materials against some land snail's species which infesting the major crops in Sharkia Governorate, Egypt.

1. Ecological studies:

Ecological studies were carried out on terrestrial molluscs which are distributed in Sharkia Governorate, these studies included survey of terrestrial molluscs that occurs on different crops, population dynamics on some field crops and effect of host plants on food consumption rate of two land snail species which predominant.

Survey study of the land snails infesting different crops Sharkia Governorate:

A survey study was carried out at three districts belonging to Sharkia Governorate during the period of January 2019 until March 2022.

A) Experimental area:

Three districts were selected to conduct the experiments, and three villages were chosen from each one. These villages were (AL-Adya,Kafer Ageba and El-Mahdya) belonging to Hehia district. (Sekm farmer, Kafer Aiob and Basateen Barakat) from Belbies district and (Bini shebl , El- Nakkaria and Manshiet Abou al Akhdar), Zagazig district.

Survey was applied on many host plant species including:

1- Field crops: Egyptian clover, (*Trifolium alexandrinum*), wheat (*Triticum aestivum*), broad bean (*Vicia faba*), and onion (*Allium cepa*).

2- Vegetables crops: cabbage (*Brassica oleracea*), lettuce (*Lactuca sativa*), and mulukhiya (*Corchorus*)

3- Horticultural crops: navel orange (*Citrus sinensis*), guava (*Psidium guajava*), mango (*Mangifera indica*) and tangerines (*Citrus reticulata*)

2. Rearing technique:

Samples were taken using quadrate sample size 50x50 cm **(Staikou *et al.* 1990)**. Snails from different host plants were collected and transferred in plastic bag to laboratory for identification using key given by **Godan (1983).**

Fig. (1): Quadrate sampling tool.

2. Control studies: snails were collected and preserved in the lab until the relevant experiments were carried out.

2.1. Tested land snails:

Culture of the tested land snail, *M. cartusiana* was collected from Egyptian clover field at Al-Awasga village, Hehia district, Sharkia Governorate. Snails of the same shell diameter directly transferred to the laboratory. Healthy individuals of the tested snails kept in two glass containers (50x30x30 cm) containing moist clay soil to a depth of about 10 cm and provided daily with fresh lettuce leaves for 10 days **(El-Okda 1984).** Snails starved for 24h before starting the experiments.

2.2. Effect of some chemical compounds as poisonous baits against *M. cartusiana* snails under laboratory conditions:

The impact of several insecticides, molluscicide, belonging to different chemical groups were used to evaluate the molluscicidal activity against two land snails, *T. pisana* and *M. cartusiana*.

3.7- preparation of poisonous baits against *M. cartusiana* snails technique:

For preparation of baits three concentration of each juice (10,20 and 40 parts) **(Ismail and Mohammed., 2009)** were incorporated with wheat bran to give 100 parts of poisonous baits and all content mixed with adequate water. The boxes checked after 1, 3, 7, 14, 21 and 28 days the dyed snails removed and recorded mortality percentages were calculated and corrected using **(Abbott's formula, 1925).**

RESULTS AND DISCUSSION

Part 1:

1- Lettuce plants parameters

1-1 Vegetative growth characters:

Data in Table (2) investigated the effect of GA_3, seaweed extract, biofertilizers, biopesticides and pesticides, vegetative growth characters of lettuce plants, plant height, number of leaves, plant fresh weight and plant dry weights.

Table (2): Effect of Biofertilizers and some Pesticides on Lettuce Plants Vegetative growth

Treatments	Plant lengths(cm)	Width (cm)	Leaf area (cm^2)	Head Fresh wight (g)	head Dry wight (g)
Control	22.293	7,920	132.370	97.000	8.333
Gastrotox	21.183	7.846	131.770	69.670	7.333
Biocyina	23.403	8.476	146.910	123.000	10.000
Biometa	22.997	8.290	137.920	105.000	9.333
Protecto	23.773	8.513	151.210	126.333	10.667
Gabbrilic Acid (GA3)	26.400	9.180	175.930	140.000	11.000
Seaweed extract. (Alge)	25.480	8.623	172.350	130.333	11.000
LSD (0.05)	3.291	1.022	38.742	35.460	3.483

The results revealed that GA_3, being the most effective vegetative growth characters of lettuce plants, followed by the treatments of seaweed extract, biopesticides, biofertilizers and control pesticides, respectively.

Regarding the important role of GA_3, **Tsiakaras *et al.* (2014)** and Miceli *et al*. (2019) reported that GA_3 activated the physiological processes in different parts of plant, which increased plant growth characters.

These results are in concurrence with those reported by **Tsiakaras *et al.* (2014)**, **Miceli *et al.* (2019)** and **Akter *et al.* (2020)**.

Respecting the vital role in plant growth characters, **Craigie (2011)** stated that seaweed extract is common in containing a high content of sterols, poly Sacclarides, N-containing compounds (betaines), numerous nourshing elements and a number of plant growth promoting substances like auxins, cytokinins, gibberellins, which increased cell elongation and increased vegetative growth parts. Similar trends were also registered by **Rasouli *et al.* (2022)** and **Montecilla *et al.* (2024)**.

As the important role of biopesticide, **Hamed *et al.* (2022)** pointed out that biopesticides are contained microorganisms carry on pesticides which control the pests and then decreased the pathogens of pests and increased the morphological characters of plant tissues.

These results are in accordance with those obtained by **Demir *et al.* (2024)**. Respecting the role of pesticides in plants, **Haile *et al.* (2000)** concluded that pesticides reduced lettuce growth and photosynthesis and increased the pollution in soil and plant then in Eco-system.

These results are supported by those recorded by **Horska *et al.* (2020)**.

1-2 Yield and its components:

The illustrated data in Table (3) clear that all treatments significantly increased yield and its components of lettuce. GA_3 treatments, being the most effective on physical parameters of lettuce, i.e. leaf length, leaf width and leaf area of lettuce. This treatment followed by seaweed extract treatment in this concern.

Table (3): Effect of Bio- Fertilizers and some Pesticides on Lettuce Plants Yield and its components

Treatments	**Leaf number**	**Plant length (cm)**	**Fresh wight(g)**	**Dry wight (g)**
Control	16.667	36.000	180.000	15.333

Gastrotox	16.300	33.333	173.000	15.333
Biocyina	17.000	37.000	211.000	19.000
Biometa	17.000	36.333	193.000	17.000
Protecto	18.333	38.000	225.000	19.667
Gabbrilic Acid (GA3)	25.333	43.000	278.000	22.000
Seaweed extract.	20.000	40.333	227.667	21.000
LSD (0.05)	2.450	4.172	33.736	3.627

The lowest value of physical characters of lettuce was obtained from pesticide treatment.

Data in the same Table revealed that yield of lettuce plants recorded highest values, i.e. fresh weight of head, Dry weight of head and total yield of head/fed. when plants treated by GA_3 treatment in the combined data.

This treatment is followed by Seaweed extract, Biocyina, Biometa and Protecto treatments, respectively.

Regarding the vital role of GA_3 on yield and yield components of lettuce plants, **Miceli *et al.* (2019)** indicated that GA_3 as hormone activates the biochemical and biophysiological processes in different parts of plant and then increased the physical parameters and yield of lettuce plants.

Respecting the important role of seaweed extract in increased physical and yield of lettuce plants, **Ali (2024)** demonstrated that seaweed extract contains many growth hormones, like gibberellins, auxins, cytokinin, which activate the elongation and cell formation of the different parts of lettuce plants, consequently increased the physical and yield components of lettuce. Obtained results are in harmony with those reported by **Tsiakaras *et al.* (2014)**, **Miceli *et al.* (2019)** and **Akter *et al.* (2020)**, who worked on GA_3, **Mohamed *et al.* (2022)**, **Rasouli *et el.* (2022)**, **Montecilla *et al.* (2024)** and **Hassan and El. Nagy (2025)** who worked on seaweed extract.

As well as **Dasgan *et al.* (2023)** who worked on biopesticides, **Meena *et al.* (2024)** who worked on biofertilizers, and **Horska *et al.* (2020)** who worked on pesticides.

Part 2:

2.1. Ecological studies on certain land snails attacking different crops at Sharkia Governorate:

Ecological studies comprise the identity of land snails infesting different crops at some districts in Sharkia Governorate.

2.1.1. Survey of the land snails in Sharkia Governorate:

Survey was conducted on land snails infesting different crops at nine villages representing three districts in Sharkia Governorate during three seasons (2023-2025). Results in **Table (4)** revealed that three species of land snails belonging to three families of order Stylommatophora found on different crops. These species were *M. cartusiana* (Hygromiidae), *E. vermiculata* (Helicidae) and *S. putris* (Succineidae) (Fig.,2).

The identified species varied in their incidence and level of infestation according to locality and host type. It was obvious that *M. cartusiana* snail has the superior incidence comparing with the other species in all surveyed localities.

Many of the examined plants were liable to be infested with *M. cartusiana* followed by *E. vermiculate* and *S. putris* which was the lowest one in this respect. The listed hosts are classified into three categories according to the degree of infestation; heavy, moderate, and light infestation. The majority of examined crops

which found with heavy or moderate infestation with *M. cartusiana* especially Egyptian clover, wheat, lettuce, cabbage, broad bean, parsley, orange, mango, guava tree and onion at nine villages in three districts at Bini shebl, Manshiaet abou AL-Akhder and EL-Nakkaria villages (Zagazig), Al-Adya, Kafer Ageba, and EI-mahdya villages (Hehia), Sekem farm, Basateen Barakat and Kafer Aiob (Bilbies destrict). The land snail, *E. vermiculata* was recorded on Egyptian clover, lettuce, broad bean, mulukhiya, orange, mango, tangerines, and cabbage in Bini shebl villages (Zagazig), Sekem farm and Basateen Barakat (Belbies).

On the other hand, *M. cartusiana* was recorded on orange, mango, tangerines, wheat, Egyptian clover, lettuce, broad bean, and cabbage at three villages: Kafer aiob, Basateen Barakat and Seke farm (Belbies) and Bini shebl, Manshiaet abou AL-Akhder and EL-Nakkaria villages (Zagazig) . Al-Adya, Kafer Ageba, and EI-mahdya villages (Hehia). Moreover, *S. putris* snail was recorded on Egyptian clover at AlAdya and ELMandya (Hehia) AL-Akhder, Bini shebl and EL-Nakkaria villages (Zagazig) Seke farm (Belbies).

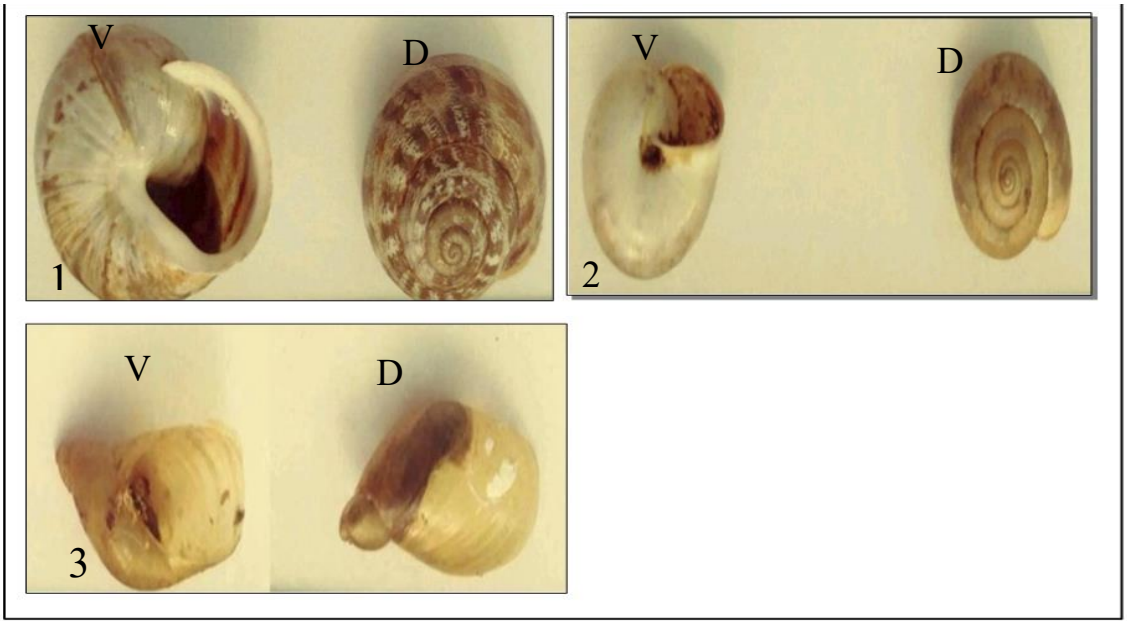


Fig.(2): Shells of the adult stages (D.: dorsum and V.: ventrum): (1) *E. vermiculata*, (2) *M. cartusiana*, (3) and *S. putris*.

Table (4): Survey of land snails and level of infestation on different crops in Sharkia Governorate during January 2022 to March 2023

District	Village or districts	Species	Host plant
Hehia	Eh Mahdya	*M. cartusiana*	Egyptian clover (+++), wheat (++), lettuce (+++), onion (+),broad (++)
		S. putris	Egyptian clover (+++)
	AL Adya	*M. cartusiana*	Egyptian clover (+++), wheat (++), lettuce (+++), cabbage (+++), parsley (++),
		S. putris	Egyptian clover (++).
	Kafr Ageba	*M. cartusiana*	Egyptian clover (+++), wheat (++), lettuce (+++), cabbage (++). broad bean (+)
Belbeis	Sekem farm	*E. vermiculata*	Mulukhiya (++), Egyptian clover (+++).
		M. cartusiana	Egyptian clover (+++), wheat (++), lettuce (+++), cabbage(++)

			guava trees (+), onion(++),
		S.. putris	Egyptian clover (+++)
	Barakat orchards	*E. vermiculata*	Navel Orange (+++), mango (++), tangerine (++), lettuce (+++), Brood bean (++).
		M. cartusiana	Navel Orange (++), mango (+), tangerines (+), lettuce (+++).
	Kafer Aiob	*M. cartusiana*	Egyptian clover (++), wheat (+), lettuce (+), cabbage (+), mango (+), Navel orange (+), guava trees (+).
Zagazig	EL-Nakkaria	*M. cartusiana*	Wheat (+++), Egyptian clover (+++), broad bean (+), cabbage (+++).
		S.. *putris*	Egyptian clover (+++)
	Bini shebl	*M. cartusiana*	Egyptian clover (+++), Brood bean (++), wheat (+), cabbage (++). lettuce (+++)
		E. vermiculata	Navel orange (+ + +), lettuce (+++) cabbage (++).
		S. putris	Egyptian clover (+ +).
	Manshiaet Abou AL- Akhdar	*M. cartusiana*	Egyptian clover (+), lettuce (+).
		S. putris	Egyptian clover (+).

(+) = Low (less than 15 snails/0.25 cm^2) (++) = Moderate (between 15-30 snails 0.25 cm^2)

(+++) = Heavy (more than 30 snails 0.25 cm^2)

2. Symptoms of damage caused by land snails on some field crops, vegetables, fruits, and ornamental plants:

Manifestation of injury caused by surveyed land snails: (*M. cartusiana*, *S. putris*, and *E. vermiculata*) at some localities in Sharkia Governorate were registered. Seriously affected vegetables and field crops feeding damage and symptoms injury associated with the infestation with land snails on vegetation's are were showed in Fig.(3)

The present results agreed with those detected by **Ismail *et al.* (2011)** recorded *M. cartusiana* and *S. putris* snails at Hehia and Meniet El-Kamh. Also, they observed *M. cartusiana* with higher density than *S. putris* on agricultural crops and weeds.

Fig.(3): Injury caused by the some species. *M. cartusiana* and *S. putris* on Egyptian clover, *M. cartusiana* on lettuce leaves, *M. cartusiana* on onion, *M. cartusiana* on cabbage, *M. cartusiana* on wheat, *E. vermiculata* on navel orange tree, and *M. cartusiana* on broad bean.

The Egyptian clover was damage while, wheat, rice, lettuce, and cabbage were moderately infested, whereas garlic and maize showed the light infestation with *M. cartusiana* **Abed (2017)**. *M. cartusiana* was recorded in high numbers in all surveyed localities followed by *S. putris* and *E. vermiculata*. Egyptian clover heavily infested followed by cabbage, while onion was the lowest one in this respect **(Kadry *et al.* 2018).** *M. cartusiana* was the most widespread species compared with *S. putris*, *C. acuta* and *E. vermiculata*. The obtained results are in harmony with **Ismail *et al.* (2017), El-Sayed (2017)**, **Bayoumi (2018), Ezzat (2021)** and **Abd El-Haleim (2022).**

3-Control studies

The Effects of some compounds against *M. cartusiana* snails as poison baits under laboratory conditions.

Table (5): Toxicity of chemical compounds baits against *Monacha cartusiana*

Comp.	Conc.	Days					
		1	3	7	14	21	28
Control	-	0	0	0	0	0	0
Gastrotox	1	0	26.7	83.3	100	100	100
	2	0	43.3	90	100	100	100
	3	0	56.7	97.7	100	100	100
Biocyna	2.5	0	0	6.7	20	20	23.3
	5	0	0	0	0	0	0
	10	0	0	3.3	13.3	20	26.7

Biometa	2.5	0	0	3.3	16.7	23.3	23.3
	5	0	0	16.7	20	23.3	30
	10	0	0	16.7	20	23.3	30
Protecto	2	0	0	0	3.3	13.3	23.3
	4	0	0	13.3	13.3	23.3	23.3
	8	0	3.3	10	10	13.3	16.6
Gabbrilic Acid (GA3)	5	0	0	0	0	0	0
	10	0	0	0	0	0	0
	20	0	0	0	0	0	0
Seaweed extract. (Alge)	5	0	3.3	13.3	13.	20	23.3
	10	0	0	0	3.3	13.3	23.3
	20	0	0	3.3	10	33.3	36.7

Six chemical compounds: Gastrotox 5%, biocyna, biometa, protecto, alge and GA3 against *M. cartusiana* snails as poison baits under laboratory conditions.

The effect of six chemical compounds: Gastrotox 5%, biocyna, biometa, protecto, Alge and GA3 were tested against *M. cartusiana snails* as poison baits under laboratory. Data in Table (6) revealed that all tested compounds failed to exhibit any molluscicidal activity one-day post treatment. Mortality percentages increased by increasing concentration and exposure periods.

As time elapsed, mortality percentages were increasing where it reached (100, 36.7, 30, 26.7 and 16.6 %) of Gastrotox, Alge, biometa, biocyna, protecto and, after 28-day post treatment, respectively. As for GA3, it did not give any molluscicidal activity at concentration 10% throughout the experiment period.

Determination of LC_{50} After 7 days of treatment for the tested biocide was the height one Biometa and the lower one GA3 compared with the LC_{50} after 3 days of treatment for the tested molluscicide.

The results indicate that the tested compounds differed markedly in their molluscicidal efficiency, with Gastrotox showing rapid, concentration- and time-dependent mortality that reached 100% within 14 days, reflecting strong acute and cumulative toxicity, in agreement with previous studies reporting the high efficacy of chemical molluscicides on land snails **(El-Okda, 1980; Abd El-Haleem *et al.*, 2015)**. In contrast, the biopesticides Biocyna, Biometa, and Protecto induced delayed and relatively low mortality that increased gradually with exposure time rather than concentration, suggesting slow-acting or sublethal effects consistent with earlier reports on microbial and botanical molluscicides **(El-Sherbiny *et al.,* 2017; Ismail *et al.*, 2020)**. Gibberellic acid (GA_3) caused no mortality at any concentration, confirming its biological safety to snails as reported by other authors **(Khalil *et al.*, 2019)**. Meanwhile, the seaweed extract exhibited moderate, time-dependent toxicity, particularly at higher concentrations, which may be attributed to the cumulative action of algal secondary metabolites, in line with findings of **Abdel-Rahman *et al.* (2021)**. Collectively, these findings support previous authors in demonstrating that chemical molluscicides remain the most effective for rapid control, whereas biopesticides and natural extracts provide slower, partial mortality that may be better suited for integrated pest management programs aiming to minimize environmental hazards.

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