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DIFFERENT CONTROL METHODS FOR REDUCING POPULATION DENSITY OF *Eobania vermiculata* (MÜLLER) UNDER FIELD CONDITIONS IN DAKAHLIA GOVERNORATE, EGYPT

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ABSTRACT: The use of chemicals to control land snails can lead to environmental pollution, hazards to humans and toxic residues in agricultural products. Therefore, finding safer alternatives for managing these pests has become a priority. Field experiments were conducted to test different methods for controlling *Eobania vermiculata* snails infested navel orange trees in Dakahlia Governorate. These methods included ploughing during the egg-laying period in January, planting cabbage traps in February, applying attractive materials in March, using pesticides in April during the activity period, and hand collection during aestivation period in June. The ploughing process significantly (P≤ 0.05) reduced the populations of *E. vermiculata*. One week after ploughing, the number of snails per sample decreased from 29.22 to 11.76, representing 63.87% reduction. After six weeks, the overall reduction in population was 40.73%. Planting cabbage traps also decreased the snail populations, with a maximum reduction of 68.54% after six weeks. Attractive materials had a significant effect on attracting populations. Sugar-cane syrup and barley powder showed the highest effectiveness, with reductions of 66.05 and 54.12%, respectively. Boiled potatoes had a moderate effect, while vanilla powder was the least effective one, with a reduction of 39.92%. Biocides and plant extracts had a significant effect on the suppression of snail populations. Oikous and clove oil had the highest effect, with 46.05 and 42.56% reduction, respectively. Protecto showed a moderate effect, while eucalyptus oil was the least effective one with 28.21% reduction. The application of pesticides also reduced the snail populations to varying degrees. The molluscicidal efficiency of the tested pesticides could be arranged in descending order after three weeks of application as follows: methomyl < fenamiphos < deltamethrin < oxamyl, with reduction percentages of 60.30, 54.41, 48.81 and 39.03%, respectively. Hand collection during the aestivation period in June also significantly (P≤ 0.05) decreased populations, with a 46.41% reduction as a general mean during the six- week experimental period. Generally, all tested control methods significantly reduced the populations of *E. vermiculata* in navel orange orchard from January to July. Based on the general means of percent reduction, the tested methods can be arranged in descending order as follows: cabbage traps, pesticides, attractive materials, hand collection, ploughing, and using biocides besides plant extracts. The reduction percentages for the snail species were 51.44, 50.64, 48.93, 46.41, 40.73 and 38.81%, respectively.

Key words: Land snails, Control, Navel orange, Dakahlia Governorate, *Eobania vermiculata.*

INTRODUCTION

Land gastropods are considered a significant threat to sustainable agricultural crops in different parts of the world (**Barker, 2002; Speiser and Kistler, 2002; Flint, 2011; Baker, 2012; Schweizer *et al*., 2019**). The importance of these land gastropods containing snails and slugs as animal pests has increased drastically in later decades (**Gathwaite and Thomas, 1996;**

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Haszprunar, 2020). Damage caused by these species due to their feeding directly on economic crops, in addition their contamination by bodies, slime or feces leading finally to deterioration of quality and quantity losses of products (**Iglesias *et al.*, 2003; Heiba *et al.*, 2018**). Its movement causes undesirable smell which could prevent human and farm animals from feeding on these crops (**El-Okda, 1984; Sallam *et al.*, 2009; Abo Zaid *et al.*, 2021**). Snails have increased and became real pests, causing considerable damage especially for horticultural crops (**Heikal, 2015**). Several species of these snails were registered in many Governorates of Egypt (**Eshra, 2014; Eshra *et al.*, 2015; Abou Senna *et al.*, 2016; Ali and Robinson, 2020**).

Control of land snails largely is dependent on the use of 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**). In addition, various reports detected molluscicidal effects formulated as poison baits (**Miller *et al.*, 1988; Hammond *et al.*, 1996; Geasa *et al.*, 2013**). Molluscicides against land snails are only occasionally delivered as sprays or dust, but poison baits techniques are still the most effective (**Barker, 2002; Ismail *et al.*, 2014**). On the other site, using molluscicides extracted from plant origin as natural products are preferable than synthetic ones (**Kumar *et al.*, 2012**). Additionally, other classes of compounds, such as biocides, bactericides, and fungicide, have been reported to have phenolic structures (**Wicht *et al.*, 2004**).

In this study, field experiments had been carried out to gain principal information concerning different control methods, which could be used safely in integrated pest management programs (IPM) for controlling *E. vermiculata* infesting navel orange fruit trees under field condition at Dakahlia Governorate.

MATERIALS AN D METHODS

Experimental Area

The experimental area in Meet Abou El-Hareth village, Aga district, Dakahlia Governorate, was heavily infested with the chocolate-band (brown garden) snail *Eobania vermiculata* (Muller). This area was planted with 10-year-old navel orange trees, *Citrus sinensis* and various types of weeds were extensively grown under the trees. The experiments were carried out during the period from January to July 2021. Within this orchard, five parallel strips, each measuring approximately 40 m wide and 50m in length, were designated as treatment sites. The selected sites were separated from each other by two parallel rows of navel orange trees.

Application of Different Control Measures for Reducing Populations of *E. vermiculata*

Effect of ploughing as a mechanical control method against *E. vermiculata*

This trial was undertaken in the first experimental site covering about half feddan to assess the impact of ploughing on diminishing populations of the chocolate-band snail, *E. vermiculata*. The site was divided into ten plots (rows) each with 8 trees. Five plots were ploughed, while the others were left without ploughing as a check control. Individuals were counted in a quadrate of 50 X 50 cm^2 under one randomly chosen tree in each plot as well as on the lower portion of the trunk up to one meter height in both ploughed and unploughed plots. Population counts were entailed 24 hrs before and after ploughing and then at weekly intervals over a six-week period starting from the beginning of January 2021. The percent reduction in population density of the snail species was calculated according to the formula given by **Henderson and Tillton (1955)** as follows: Reduction (%)=[1-(t2xr1)/(t1 x r2)]x100. where; (r1 &r2) represent number of alive snails before and after treatment in untreated plots, and (t1& t2) represent number of alive snails before and after treatment in treated plots. Data were statistically analyzed using F test between treatments were calculated at 5% significance level.

Effect of planting cabbage traps as an agricultural control method against *E. vermiculata*

This trail was conducted at the second experimental site to assess the impact of planting cabbage, *Brassica oleraceae* as traps on decreasing populations of *E. vermiculata* infested navel orange trees. The experimental site was divided into ten plots, each containing 8

trees. Five plots were planted with cabbage at a rate of 4 plants between two trees, while the remaining plots were left unplanted as a control treatment. Individuals of the snail species were counted in a quadrate of 50 x 50 cm^2 under one randomly selected tree in each plot as well as on the lower portion of the trunk up to one meter height in both the cultivated and control plots. Population counts were entailed 24 hrs before and after planting and then at weekly intervals over a six-week period starting from the beginning of February 2021. The reduction percentage in snail population density was calculated according to the formula of **Henderson and Tillton (1955)**. F test between treatments were calculated at 5% significance level.

Effect of attractive materials as an agricultural control method for *E. vermiculata*

This study was conducted, in the third half-feddan experimental site to assess the impact of attractive materials on reducing populations of *E. vermiculata*. The site was divided into ten plots (rows) each containing 8 trees. Five plots were used for the experiment, while the others were served as a control. The tested attractants included boiled potatoes, barley powder, milk powder, sugar-cane syrup, vanilla powder and yeast powder were applied as baits (10 parts water + 5 parts of each attractant + 85 parts wheat bran). Each treatment was replicated 3 times. Baits were placed on plastic trays with 100 gm of 4-baits between two trees. The number of dead and alive snails was counted using 0.25m^2 quadrate placed next to the bait before and after one day of application and then at 2-day intervals during the experimental time started from the beginning of March 2021. Reduction percentages were calculated using the formula of **Henderson and Tillton (1955)**. Data were statistically analyzed using F test between treatments at 5% significance level.

Efficiency of biocides, plant extracts and pesticides in reducing *E. vermiculata* populations

In this experiment two biocides and two plant extracts as non-chemical compounds along with four commonly used pesticides as chemical compounds, were used to control populations of *E. vermiculata* in orchard trees. The tested compounds were obtained as fresh formulated products directly from market or from the central agricultural pesticides' laboratory, Dokki, Giza, Egypt. The classes of these compounds, chemical group, common name, trade name, formulation type and chemical or scientific name were as follows:

Tested compounds Biocides

1. Oikous, (Azadirachtine, 3.2% E.C), Insecticide biocide.
2. Protecto, (Bacteria, 10% W.P), Insecticide biocide.

Bacteria formulation: *Bacillus thuringiensis*

Plant extracts

1.Clove oil (*Syzgium aromaticum*).

2.Eucalyptus oil. (*Eucalyptus obliqua*).

Insecticides

1.Deltamethrin. (Kafrothrin,2.5% E.C), Pyrethroid ester insecticide.

2.Methomyl. (Neomyl, 20 % S.L), Carbamate insecticide.

Nematicides

D.1. Fenamiphos. (Nemaphos, 40% E.C), Nematicide.

D.2. Oxamyl. (Vydate, 24 % S.L), Nematicide.

Chemical formula: ($C_7H_{13}N_3O_3S$)

Molluscicidal activity

The fourth experimental site was divided into 10 plots (rows), each with 8 trees. Five plots were treated with toxicants, while the others were left untreated as a control. The toxicants were applied as poisonous baits at concentration of 2 % a.i. (2 parts of toxicant + 5 parts of sugar-cane syrup + 93 parts of wheat brane) for each chemical compound (deltamethrin, methomyl, fenamiphos and oxamyl), and (5 parts of biocide or plant extract + 5 parts of sugar-cane syrup + 90 parts of wheat brane) for each unchemical compound (oikous, protecto, clove oil and eucalyptus oil). Control treatment was designed in the same manner without pesticides. Baits were offered on plastic trays each containing 100 gm at rate of 4 baits between two trees.

Individuals of the snail species were counted in a 50 x 50 cm^2 quadrate under one randomly chosen tree in each plot and on the lower portion in the trunk of the same tree to about one meter height. Population counts were entailed 24 hrs. before and after application and then, at intervals of two days during the experimental period starting from the beginning of April 2021. Reduction percentages were calculated according to the formula of **Henderson and Tillton (1955)**. Data were statistically analyzed using F test between treatments at 5 % level.

The effectiveness of hand collection as a mechanical control method for *E. vermiculata*

This trial was undertaken during the aestivation period at the fifth experimental site to assess the impact of hand collection in reducing populations of the chocolate-band (brown garden) snail, *E. vermiculata*. The site was divided into ten rows, each containing 8 trees. Five rows were subjected to hand collection by two workers, while the other five rows were left without collection as a control. Individuals of snail species were counted in a quadrate of 0.25 m^2 under one randomly selected tree in each plot as well as on the lower portion of the trunk up to one meter in height. Population counts were entailed 24 hrs. before and after hand collection and then at weekly intervals during the experimental time started from the beginning of June 2021. The percentage reduction in population density of the snail species was calculated using the formula of **Henderson and Tillton (1955)**. Data were statistically analyzed using F test between treatments at 5% significance level.

RESULTS AND DISCUSSION

A series of field trials were conducted to investigate effective control methods for reducing populations of the chocolate-band (brown garden) snail, *E. vermiculata*, in a navel orange orchard in Dakahlia Governorate from January to July 2021. The trials included ploughing during the egg-laying period in January, planting cabbage (*B. oleraceae*) as traps in February, applying attractive materials in March, and using pesticides as poisonous baits in April during the snails' activity period. Finally, hand collection was conducted during the aestivation period in June.

Application of Different Control Measures for Reducing *E. vermiculata* Populations

Effect of ploughing process as a mechanical control method for *E. vermiculata*

The data presented in Table 1 provided valuable insights into this method. The results clearly showed that ploughing significantly ($P \leq 0.05$) decreased the populations of *E. vermiculata*. One week after ploughing, the number of snails per sample decreased from 29.22 to 11.76, representing a 63.87% reduction. Two weeks after ploughing, there was a 53.68% reduction in populations.

This trend continued, with a slight increase in percentage reduction four and five weeks after ploughing. However, after six weeks, the percentage reduction decreased to 22.30%. Generally, ploughing as a mechanical control method during the egg-laying period resulted in a significant ($P \leq 0.05$) reduction in populations, with a general mean of 40.73% after six weeks of application.

Effect of planting cabbage traps as an agricultural control method for *E. vermiculata*

In the search for alternatives to chemical control of land snails in orchard trees, the obtained data presented in Table 2 clearly indicated that planting cabbage traps between navel orange trees decreased the populations of *E. vermiculata*. One week after planting, the number of snails was reduced from 22.13 to 18.92 snails per sample, recording a 26.21% reduction. Three weeks after planting, the percent reduction in populations was 49.37%. This trend continued, with a gradual increase in percent reduction of the snail species. After the sixth week, a maximum percent reduction of 68.54% was recorded. The general mean of percent reduction in populations during the whole experimental period was 51.44%. Therefore, it can be concluded that planting cabbage traps as an agricultural control method showed a significant ($P \leq 0.05$) reduction in populations of *E.vermiculata.*

Table 1. Effect of ploughing process as a mechanical control method against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during January 2021

Weeks after application	Mean number of snails per sample		(%) Reduction
	Control area	Ploughed area	
1	29.22	11.76	63.87
2	30.37	15.86	53.68
3	31.51	19.22	43.49
4	31.30	22.37	37.64
5	32.45	27.51	23.41
6	32.55	28.46	22.30
General mean	31.23a	20.86b	40.73

Each number represents the mean of five replicates.
General means followed by different letter are significantly different at 0.05 level, according to **Duncan (1955)**.

Table 2. Effect of planting cabbage traps as an agricultural control method against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during, February 2021

Weeks after application	Mean number of snails per sample.		(%) Reduction
	Control area	Planted area	
1	22.13	18.92	26.21
2	24.20	16.83	37.13
3	25.18	14.63	49.37
4	26.49	11.44	62.42
5	26.38	11.99	64.97
6	27.36	10.67	68.54
General mean	25.29a	14.08b	51.44

Each number represents the mean of five replicates.
General means followed by different letters are significantly different at 0.05 level, according to **Duncan (1955)**.

Effect of attractive materials as an agricultural control method for *E. vermiculata*

The aim of the present study is to determine the most effective attractive materials for increasing the molluscicidal efficiency of pesticides in controlling *E. vermiculata.* Data presented in Table 3 indicated that the tested materials had a significant effect on attracting snail populations. Since, general means of percent reduction after two weeks of application using boiled potatoes, barley powder, milk powder, sugar-cane syrup, vanilla powder and yeast powder as attractants were 46.43, 55.52, 43.12, 67.77, 40.96, and 47.44%, respectively. The same trend was observed after 3 weeks of application with a slight increase in percentage reduction recording parallel values of 43.94, 52.54, 40.81, 64.13, 38.76 and 44.90%, respectively. According to general means of percent reduction during the whole trail sugar-cane syrup and barley powder gave the highest effect recording 66.05 and 54.12%, respectively. Whereas boiled potatoes and yeast powder showed moderate effect in reducing numbers of snails. While milk powder and vanilla powder were the least effective compound with percent reduction of 42.03 and 39.92%, respectively.

Table 3. Effect of attractive materials as an agricultural control method against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during, March 2021

Compounds	Control treatment	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Boiled potatoes	63.17	50.52	51.03	46.43	34.36	43.94	45.26c
Barley powder	70.12	60.41	61.01	55.52	41.09	52.54	54.12b
Milk powder	63.23	46.92	47.39	43.12	31.91	40.81	42.03de
Sugar-cane syrup	76.86	73.73	74.47	67.77	50.15	64.13	66.05a
Vanilia powder	62.42	44.56	45.01	40.96	30.31	38.76	39.92e
Yeast powder	63.61	51.62	52.14	47.44	35.11	44.90	46.24cd

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 biocides and plant extracts as non-chemical control methods in reducing populations of *E. vermiculata*

E. vermiculata. Data presented in Table 4 indicated that the tested compounds had a significant effect on the attraction of snail populations. General means of percentage reduction after two weeks of application using Oikous, Protecto, Clove oil, and Eucalyptus oil, as molluscicides were 44.26, 36.87, 40.91 and 27.11%, respectively. The same trend was observed after three weeks of application with a slight increase in percentage reduction recording parallel values of 44.68, 37.22, 41.30 and 27.37%, respectively. According to general means of percent reduction during the whole period Oikous and Clove oil gave the highest effect recording 46.05 and 42.56% reduction, respectively. Whereas Protecto showed a moderate effect in reducing numbers of snails, while Eucalyptus oil was the least effective compound with a percent reduction of 28.21%.

Efficiency of pesticides as chemical control methods in reducing populations of *E. vermiculata*

Data presented in Table 5 clearly showed that the tested pesticides reduced populations of *E. vermiculata* snail to varying degrees, since percent reduction differed significantly from one pesticide to another. According to general means of percent reduction during two weeks after treatment; methomyl and fenamiphos gave the highest effect recording 65.14 and 58.78%, respectively. Whereas deltamethrin showed moderate effect in reducing numbers by 52.72% while, oxamyl was the least effective compound with percent reduction of 42.17%. The same trend was observed after 3 weeks of application with a slight increase in percentage reduction recording parallel values of 59.93, 54.08, 48.51 and 38.80% with methomyl; fenamiphos and deltamethrin and oxamyl, respectively. Generally, the molluscicidal efficiency of the tested pesticides according to general means of percent reduction against the snail species could be arranged in descending order as follows: methomyl < fenamiphos < deltamethrin < oxamyl recording reduction percentage of 60.30, 54.41, 48.81 and 39.03%, respectively.

Efficacy of hand collection as a mechanical control method of *E. vermiculata*

The efficiency of hand collection method in controlling *E. vermiculata* was studied in a chosen navel orange orchard highly infested with snail species during the aestivation period in June 2021. The obtained data in Table 6 clearly indicated that hand collection obviously decreased populations. One week post collection, the number of snails was reduced from 38.80 to 22.66 snails per sample recording 54.49% reduction while the corresponding numbers after three weeks reduced from 36.86 to 23.69 snails

Table 4. Efficiency of certain biocides and plant extracts as non-chemicals control methods against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during, April 2021

Compounds	Control treatment	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Oikous, biocide	66.61	51.52	62.34	44.26	27.44	44.68	46.05ab
Protecto, biocide	59.17	42.92	51.93	36.87	22.86	37.22	38.36c
Clove oil, extract	62.23	47.62	57.62	40.91	25.36	41.30	42.56bc
Eucalyptus oil, extract	53.42	31.56	38.19	27.11	16.81	27.37	28.21d

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 5. Efficiency of certain pesticides as chemical control methods against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during, April 2021

Compounds	Control treatment	(%) Initial effect	(%) Reduction after treatment (in days)			(%) Residual effect	General mean
			7	14	21		
Deltamethrin, 2.5% EC	39.64	49.99	51.69	52.72	41.12	48.51	48.81c
Methomyl, 20 % SL	50.43	61.76	63.86	65.14	50.81	59.93	60.30a
Fenamiphos, 40% EC	46.32	55.73	57.62	58.78	45.85	54.08	54.41b
Oxamyl, 24 % SL	38.97	39.98	41.34	42.17	32.89	38.80	39.03d

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. Efficacy of hand collection as a mechanical control method against *E. vermiculata* infesting navel orange trees in Dakahlia Governorate during, June 2021

Weeks after application	Mean number of snails per sample		(%) Reduction
	Control area	Collected area	
1	38.80	22.66	54.49
2	32.01	20.60	51.46
3	36.86	23.69	50.45
4	25.22	18.54	43.39
5	22.31	17.51	40.36
6	19.40	16.48	38.34
General mean	29.10a	19.91b	46.41

* Each number represents the mean of five replicates.
General means followed by different letters are significantly different at 0.05 level, according to **Duncan (1955)**.

per sample recording 50.45% reduction. The same trend was observed after four and five weeks of collection with a gradual decrease in percentage reduction. However, after the sixth week the percentage reduction in numbers sharply declined to 38.34%. Finally, the hand collection method showed significant effect on percent reduction for the snail species recording 46.41% reduction as a general mean during the total experimental period.

Effect sequence different control methods on an integrated pest management (IPM) program against *E. vermiculata* infesting navel orange trees under field conditions.

To reduce the chemical treatment in controlling land snails and search for more effective processes for successful IPM programs, the following methods were tested for controlling *E. vermiculata*: ploughing process as a mechanical control method, planting cabbage traps and using attractive materials as agricultural control methods, applied biocides and plant extracts as non-chemical control methods, using pesticides as chemical control method, and hand collection as a mechanical control method, The efficiency of tested methods against *E. vermiculata* under field conditions in navel orange orchard, according to their general means of percent reduction could be arranged in descending order as follows: planting cabbage traps< using pesticides < using attractive materials > hand collection < ploughing process < using biocides and plant extracts. The general reduction percentages at the end of applications for the snail species were recorded as: 51.44, 50.64, 48.93, 46.41, 40.73 and 38.81%, respectively (Fig.1).

Where, PP= Plowing process as a mechanical control method, CT = Cabbage traps as an agricultural control method, AM = Attractive materials as an agricultural control method, BP = Biocides and plant extracts as non-chemical control method, US = Using pesticides as chemical control method., HC = Hand collection as a mechanical control method.

Before discussing the foregoing results, it is important to note here that, problems caused by snails and slugs on agricultural crops have been reported by many authors in most countries of the world (**Baker, 1989; Newman *et al.*, 1994; Castielleio *et al.*, 1996**). In Egypt, land snails have been reported in different Governorates attacking many economic crops. Moreover, incidence of land gastropod species has been mentioned by many authors in different Governorates (**Ismail *et al.*, 2011; Rady *et al.*, 2014; Kadry *et al.*, 2018; Abd El-Haleim *et al.*, 2022**).

Our obtained results agree with the finding of **Wouters (1970)**, who showed that rough ploughing of the soil before sowing winter wheat protected seeds from damage caused by land snails. Moreover, **El-Deeb *et al.* (2003)** reported that the efficacy of tillage process depends on land snail species and period after tillage, and it was effective against *M. cartusiana* compared to *E. vermiculata* two months after tillage. When discussing the results related to planting cabbage as traps, many authors (**Staikou and Lazaridou- Dimitriadou, 1989; Ghamry *et al.*, 1994; Sean *et al.*, 2015, Ibrahim, *et al.*, 2017**) discussed the host preference for land snails. They reported that snails fed on lettuce showed higher assimilation efficiency than those fed on *Urtica dioica*. Leaves of pea and lettuce were the most preferable food for *M. cartusiana*, while leaves of lettuce and cabbage were the most favorable hosts for *E. vermiculata* and *M. cartusiana* compared with other tested food leaves.

In their study on attractive materials for reducing population of land snails, **El-Sebae *et al.* (1982)** found, bran baits containing radish and ragee elkone gave higher percentage of snail mortality compared to nokhalah and germah. **Godan (1983)** mentioned that molasses and wheat bran were the most effective in mixtures with molluscicides, along with boiled potatoes, dry milk powder, rice bran which were added as attractants in poisonous bait techniques. **Asran (1994)** indicated, bran was the most preferable bait for *H. aspersa* followed by crushed wheat and crushed maize, with sugar-cane syrup being the most attractive additive substance followed by molasses, while vanilla was the least attractive material. In studying the efficiency of certain biocides and plant extracts (**Prakash and Rao, 1997; Batish *et al.*, 2008; Keith, *et al.*, 2009; Howlett, 2012)** tested plant products known to possess molluscicidal activity against land snails as well as, plant parts and formulations with

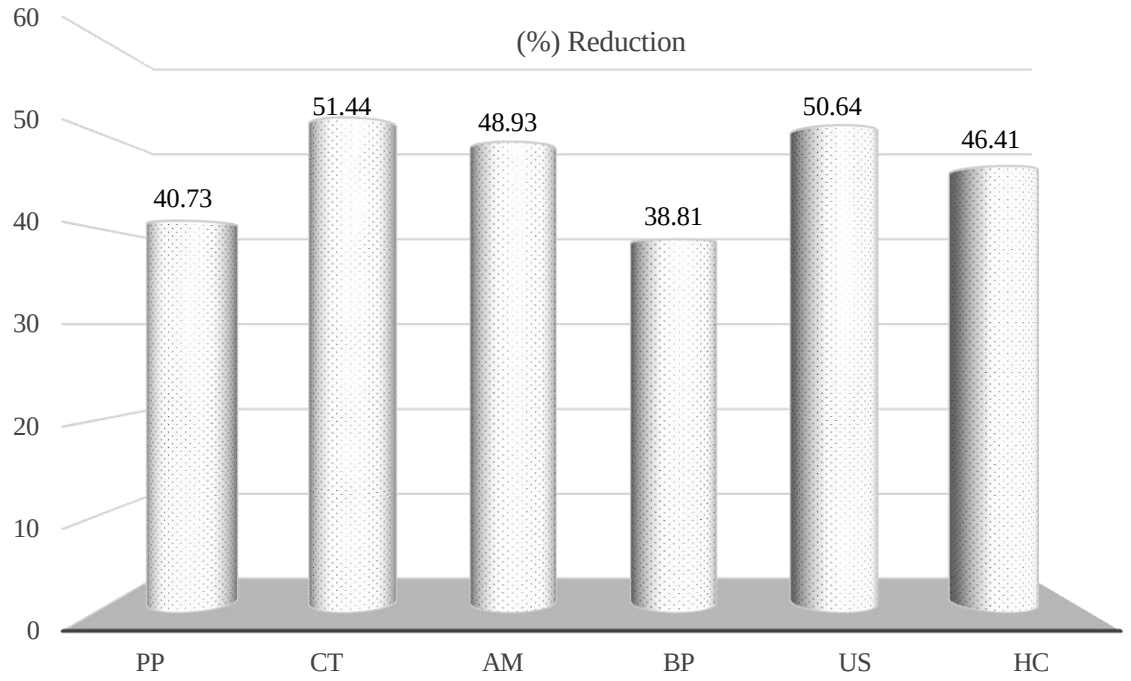

Fig. 1. Effect of sequential processes against *E. vermiculata* infesting navel orange orchard in Dakahlia Governorate during the period from January to July 2021 for IPM program

biological activity against land snails. Azadirachtin, and other active components from neem, was also reported to show mulluscicidal activity against *Lymnea luteda* (**Ramesh, 1983**). Also, **Kady *et al.* (1986)** attributed the mulluscicidal action of the wild herb, *Peganum harmala* to its alkaloidal constituents which affect the respiration and/or the nervous system of snails. **Kishor and Sati (1990)** reported that spirostanol glycoside from the plant, *Yacca aloifolia* was 100 % toxic at 10 ppm when tested against *Biumphalaria glabrata* snails.

The results obtained from the use of pesticides agree with those reported by many authors. **Godan (1983)** showed that 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*, and organophosphorous 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, similar results had been recommended by several authors *i.e.*, **Aioub *et al.* (2000) and Elsayed *et al*. (2022)**. 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; Nakhla *et al*., 2002; Abo Bakr, 2011**). Therefore, application of molluscicides is effectively applied during the month of April.

When discussing the results of hand collection, it is worthy to mention that hand collection methods have been recommended by several authors (**Wouters, 1970; Godan, 1983; Shah, 1992; Tillier *et al*., 1995**). Accordingly, ploughing or tillage can be successfully applied when snails aestivate during summer months starting from June. During this time, the animals

retract into their shell and seal the shell aperture with one or more epiphragms (**El-Masry, 1997; Mahrous *et al.*, 2006**). Also, **Carman (1965)** illustrated that hand collection with subsequent squashing of snails was the oldest mechanical method and reported that spraying chemicals during the summer proved to be ineffective in controlling land snails. **Shah (1992)** indicated that collecting the snail *Achatina fulica* especially during aestivation period, gave good control and reduction in population density. Moreover, **Tillier *et al.* (1995)** reported that physical control of land snails by creating barriers of bare around the crop was the most effective method. In conclusion, integrated pest management (IPM) has become an economic necessity and is vital for modern agriculture. This includes all methods using control procedures to suppress gastropod populations to non-damaging levels.

REFERENCES

Abdallah, E.M., F.A. Kassem, H.B. El-Wakil and Y. Abo-Baker (1999). Molluscicidal potentiality of several pesticides against *Eubania vermiculata* and *Theba pisana*. Ann. Agric. Sci., 1: 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 Governorates, 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. Biolog. Sci., 13 (2): 95-103 doi:10.21608/eajbsz.2021. 196691.

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.

Ali, R.F. and D.G. Robinson (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). Zool. and Ecol., 138-156.Https:// doi.org /10.35513 / 21658005.2020. 2.8.

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, 78: 290 –296 doi:10.1093 / mollus/eys015.

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

Batish, D.R., S.H. Pal, K.R. Kumar and K. Shalinder (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.

El-Deeb, H.I., A.K. Sobeiha, M.M. Fouad and F.D.A. Asran (2003). Utilization of some mechanical and cultural measures against terrestrial snails. Zagazig J. Agric. Res., 30 (6): 2371 2383.

El-Masry, S.A.A. (1997). Studies on the control of some land snails infesting certain fruit trees. Ph.D. Thesis, Fac. Agric. Zagazig Univ., 158.

El-Okda, M.M. (1984). Land mollusca infestation and chemical control in El-Ismaelia Governorate. Agric. Res. Rev., 62 (1): 87-92.

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. Marei (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. Pest., 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.

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 and 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 Agric. 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. Egypt. 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. a0029219.

Heiba, N.F., M.M. Mortada, S.N. Geassa, A.I. Allam and Abd S.I. 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.

Heikal, M.H. (2015). Biological aspects and population dynamics of three terrestrial snails infesting fruit trees in Egypt. Int. J. Adv. Res. Biol. Sci. 2(1): 169 –180.

Henderson, G.F. and Tillton, E.W. (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, earthworms, nematodes, acarids and collembolans: a two-year study in north–west Spain. Pest. Manag. Sci., 59: 1217-1224.

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.

Kady, M.M., A.H. El-Sebae, A.A. Abd El-Ghany and H.A. Zedan (1986). Alkaloids with molluscicidal activity from the wild herb *Peganum harmala* (L.). J. Agric. Sci. Mansoura Univ., 11: 1246-1251.

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 behaviour of the nematode *Phasmarhabditis hermaphrodita* in mineral soils and organic media soil, Biol. Biochem., 41: 1483–1490 doi:10.1016 /j. soilbio.2009.04.007.

Kishor, N. and O.P. Sati (1990). A new molluscicidal spiro stanol glycocide of *Yacca aloifolia*. J. Natural Prod., 53: 1557-1559.

Kumar, S., N. Wahab, M. Mishra and R. Warikoo (2012). Evaluation of 15 local plant species as larvicidal agents against an Indian strain of Dengue fever mosquito, *Aedes aegypti* L. (Diptera: Culicidae). Frontiers in Physiol., 3:104

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.

Nakhla, J.M., A.W. Tadros and N. El-Hawashy (2002). Monitoring the changes in the population activity of *Monacha obstructa* in apple orchard and Egyptian clover fields in Giza Governorate, Egypt. J. Agric. Res., 80 (1): 95-109.

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.

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.

Rady, G.H., A.A. Abd Elgawad, S.H.A. Ismail and 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.

Ramesh, B.G. (1983). Neem extract destroys snails. Sci. Reporter (India) Dec., 23.

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: 389-94.

Staikou, A. and M. Lazaridou-Dimitriadou, (1989). Feeding experiments and energy flux in a natural population of the edible snail, *Helix lucorum* L. (Gastropoda: Pulmonata: Stylommatophora) in Greece. Malacologia, 31 (1): 217-227. (c.f. Rev. Agric. Entomol., 1990, 78 (6): 617)

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

Wicht, M.J., R. Haak, H. Schütt-Gerowitt, S.M.J. Kneist and M.J. Noack (2004). Suppression of caries-related microorganisms in dentine lesions after short-term chlorhexidine or antibiotic treatment. Caries Res., 38: 436-441.

Wouters, L. (1970). Schneckenbkampfung in oostflevoland. Pflanzen schutz-Nachr., Bayer, 23: 173-177. (c.f. Pest Slugs and Snails, Biology and Control, Ed. Godan, D., Springer-Verlag, Berlin Heidelberg, 1983.

طرق مكافحة مختلفة لتقليل أعداد قوقع *Eobania vermiculata* (Müller) تحت الظروف الحقلية بمحافظة الدقهلية ، مصر

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تسبب المواد الكيميائية المستخدمة في مكافحة القواقع الأرضية تلوثًا بيئيًا ومخاطر للإنسان، بالاضافة الى المتبقيات السامة فى المنتجات الزراعية، لذا أصبح البحث عن طرق امنة بديلة لمكافحة هذه الآفات أمراً ضروريا، لذلك تم إجراء تجارب حقلية باستخدام طرق مكافحة مختلفة في احد بساتين البرتقال بسرة بمحافظة الدقهلية والمصاب بالقوقع الشيكولاتى المخطط (قوقع الحدائق البني) *Eobania vermiculata* ، حيث اشتملت هذه الطرق على: الحرث أثناء فترة وضع البيض في شهر يناير، وزراعة مصائد نباتية من الكرنب في شهر فبراير، ثم تطبيق لبعض المواد الجاذبة في شهر مارس، واستخدام المبيدات خلال فترة النشاط في شهر أبريل، والجمع اليدوي خلال فترة البيات الصيفي في شهر يونيو، حيث أدت عملية الحرث إلى انخفاض أعداد قواقع *E. vermiculata* بصورة معنوية بعد أسبوع واحد من التطبيق من 29.22 إلى 11.76 فرد في العينة مسجلاً بذلك انخفاضاً في التعداد مقداره 63.87% ، بينما تم تسجيل انخفاض في أعداد الافراد بمتوسط عام مقداره 40.73% بعد ستة أسابيع من عملية الحرث. وأدت زراعة مصائد نباتية من نباتات الكرنب إلى انخفاض أعداد قوقع الحدائق البني بعد الأسبوع السادس من الزراعة بنسبة 68.54% ، بينما كان تأثير المواد الجاذبة المختبرة معنويا في جذب الافراد الي الطعوم حيث أعطى استخدام عصير قصب السكر ومسحوق الشعير أعلى تأثير بلغ 66.05 و54.12 % علي التوالي. بينما أظهر استخدام البطاطس المسلوقة تأثيراً متوسطاً في حين أظهر استخدام الفانيليا أقل فعالية بنسبة خفض في التعداد مقدارها 39.92%. وكان للمبيدات الحيوية والمستخلصات النباتية تأثير معنويا على قمع أعداد القوقع ، حيث أعطى مركب الأويكوس وزيت القرنفل أعلى نسبة تأثير ومعدل انخفاض بنسبة 46.05 و42.56% على التوالي، في حين أظهر مركب البروتكتو (بكتيريا الباسيلس) تأثيراً متوسطاً في تقليل الأعداد، بينما كان زيت الكافور هو الأقل فعالية في خفض تعداد الافراد بنسبة 28.21%، وأدى استخدام المبيدات الي خفض التعداد أيضا بدرجات متفاوتة، وأمكن ترتيب كفاءة المبيدات المختبرة ضد القوقع تنازليا بعد ثلاثة أسابيع من التطبيق على النحو التالي: ميثوميل > فيناميفوس > دلتامثرين> أوكساميل، حيث بلغت نسبة الانخفاض في التعداد 60.30 ، 54.41 ، 48.81 و39.03% على التوالي، وأظهرت عمليات الجمع اليدوي فعالية في خفض تعداد القوقع خلال فترة البيات الصيفي في شهر يونيو مسجلة انخفاضًا واضحًا في الأعداد بلغ 46.41% كمتوسط عام خلال الفترة التجريبية التى امتدت الى ستة أسابيع، وعموما فقد ادى استخدام جميع الطرق المختبرة الى الانخفاض المعنوى فى تعداد القوقع الشيكولاتى المخطط *E. vermiculata* في بستان البرتقال ابوسرة خلال الفترة من شهر يناير إلى يوليو ووفقا للمتوسط العام لنسبة الانخفاض التي تحدثها كل طريقة أمكن ترتيبها تنازلياً كما يلي: استخدام مصائد الكرنب > المبيدات الكيماوية > المواد الجاذبة > الجمع اليدوي > عمليات الحرث > استخدام المبيدات الحيوية والمستخلصات النباتية بنسب انخفاض مقدارها 51.44 ، 50.64 ، 48.93، 46.41، 40.73 و38.81% على التوالي.

الكلمات الإسترشادية: القواقع الأرضية، المكافحة، البرتقال بسرة، محافظة الدقهلية، *E. vermiculata*.