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OCCURRENCE, POPULATION DENSITY AND SEASONAL POPULATION DYNAMICS OF LAND SNAILS INFESTING MAJOR CROPS IN DAKAHLIA GOVERNORATE, EGYPT

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ABSTRACT: Results of a survey carried out on land gastropods infesting major field, vegetable and fruit crops in 12 villages (localities) representing four districts (counties) of Dakahlia governorate through the seasonal activity period of gastropod species during two successive growing seasons 2018/2019 and 2019/2020 revealed the occurrence of three land snail species and one slug species belonging to order: Stylommatophora. The snail species were, the glassy clover snail *Monacha cartusiana* (Muller) family: Hygromiidae, the brown garden (chocolate-band) snail *Eobania vermiculata* (Muller) family: Helicidae and the succineid snail *Succinea* sp., family: Succineidae, while the slug species was *Deroceras* sp., family: Agriolimacidae. The identified species varied in their incidence according to host plant, locality and season. In this respect, *M. cartusiana* snail has the upper hand, since it was detected in most of all surveyed localities infesting the majority of examined crops. It was more abundant on field and vegetable crops compared to fruit trees. *E. vermiculata* was found on all examined fruit crops. It was not detected on any of the studied field or vegetable crops at all surveyed localities. On contrary, the succineid snail *Succinea* sp. was found on field and vegetable only, it was not observed infesting fruit crops. On the other hand, the slug *Deroceras* sp. was found in certain localities infesting all examined crops except wheat, broad bean and potato. Population density of *M. cartusiana* differed from host plant to another and from locality to another. Among field and vegetable crops, Egyptian clover and lettuce gained the highest values while wheat and potato showed the lowest ones. Since, the highest number of this snail on Egyptian clover and lettuce were counted in Borg El-Nour village (Aga district) and Batra village (Talkha district) during 2018/2019 and 2019/2020 seasons with values 29.9, 25.6 (21.1, 19.5) and 27.7, 23.2 (24.4, 22.5) snails per 50 x 50cm², respectively. Whereas, other identified gastropod species were found with relatively lower occurrence and population density on the infested crops. The seasonal population behavior of the predominant species, *M. cartusiana* was monitored on Egyptian clover and wheat during two successive seasons (2019/2020 and 2020/2021). It was found that population density increased during spring months as compared to low or moderate values during autumn and winter months.

Key words: Land gastropods, *Monacha cartusiana*, occurrence, population density, population behavior, Dakahlia Governorate.

INTRODUCTION

In recent years, land gastropod species are considered one of the most important animal pests reducing production of different crops. Movement of gastropod species on the infested

plant parts cause indirect damage by left unpleasant slimy tracks making humans and farm animals refuse eating on these plants (Sallam *et al.*, 2009). Crops attacked by these pests lose their marketability and hence their export potential in many countries (Baker and

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Hawke, 1990). In addition, many of land snails are known to serve as intermediate hosts to human and livestock parasites of Platyhelminthes (**Grewal et al., 2003; Rashed, 2008**) as well as the nematode parasite *Angiostrongylus cantonensis* in Egypt (**Yousif and Ibrahim, 1978**). Moreover, they act as vectors of many plant pathogens (**Alvarez et al., 2009**). Generally, the importance of terrestrial snails is now becoming obvious with descend in the economic importance of insect pests due to development of effective control strategies (**Barker, 2002**).

Problems caused by gastropod pests on agricultural crops were reported in several countries of the world. In Egypt, up till 1980 it was established that land gastropod pests have been concentrated mostly in northern governorates of the Nile Delta region such as Alexandria and Beheira. However, at present time they occur in all Delta governorates infesting field and vegetable crops as well as fruit trees and ornamental plants. Moreover, in Upper Egypt, land gastropods were found on many economic crops in Fayoum, Menia, Assuit and Sohag governorates. The most abundant species in Egypt were, *Monacha* spp., *Eobania vermiculata*, *Cochlicella acuta*, *Succinea* spp. and *Deroceras* spp. (**El-Deeb et al., 1996; Mahrous et al., 2002; Desoky et al., 2015; Mohamed, 2015; Abd El-Halim et al., 2021**). Generally, the damaging effects of these pests is far greater today than in former times, since limits for their dispersal have not existed as a result of denser and faster transport and traffic. Also, large snail populations can be built up mainly because parasites and predators which occurred in their original area do not exist in the newly established area (**Godan, 1983**). Moreover, land snails are capable of spreading to new areas due to their ability to tolerate unfavorable climatic factors such as high temperatures and dry conditions, which considered the main climatic factors that influence their activity and occurrence. Also terrestrial snails possess high fecundity and ability to live in new habitats (**Cook, 2001; Schweizer et al., 2019**).

Control methods depend greatly on ecological and biological information of land snail infestation. It helps in choosing the suitable and safety control methods which are very necessary to protect crops from damage caused by these

pests. Therefore, many authors studied population dynamics of the most abundant land snail species attacking different crops at almost Egyptian governorates *i.e.*, Sharkia (**Ismail et al., 2017**) Gharbia (**Abo-Zaid et al., 2021**), Kafr El-Sheikh (**Shahawy et al., 2018**), Dakahlia (**Mortada, 2002**), Dumyatt (**Awad, 2014**), Beheira (**Abd-Elhaleim et al., 2022**), Fayoum (**Abd El-Halim et al., 2021**), Qalubiyah (**Khidr et al., 2020**) and Assiut (**Ibrahim et al., 2020**). Generally, the objective of the present study is to study the occurrence of terrestrial gastropods on the major economic field, vegetable and fruit crops in three locations (villages) at each of four districts in Dakahlia governorate and to study the seasonal population behavior of the most predominant land snail *M. cartusiana* on certain field crops.

MATERIALS AND METHODS

Occurrence of Terrestrial Gastropods Infesting Certain Field and Vegetable Crops Besides Fruit Orchards in Dakahlia Governorate

A survey study was carried out at four districts (counties) of Dakahlia governorate *i.e.*, Aga, Meniet El-Nasr, Sherbeen and Talkha through the seasonal activity period of gastropod species during two successive growing seasons 2018/2019 and 2019/2020. At each district, three villages (localities) were chosen representing different directions at each district. These villages were Burg El-Nour, Meet Abou El-Hareth and Damas (Aga district); El-Kordy, Meet Assem, and Berembal (Meniet El-Nasr district); Bosat Karam El-Deen, El-Hisas and El-Sabriah (Sherbeen district) and Batra. El-Tawela and Goger (Talkha district). These villages were characterized by clay soil and surface irrigation system. The survey was undertaken on field crops *i.e.*, Egyptian clover, *Trifolium alexandrinum* L. (Fabaceae); wheat, *Triticum aestivum* L. (Poaceae) and broad bean, *Vicia faba* L. (Fabaceae), besides vegetable crops *i.e.*, cabbage, *Brassica oleracea* L. (Brassicaceae); lettuce, *Lactuca sativa* L. (Asteraceae) and potato, *Solanum tuberosum* L. (Solanaceae), as well as fruit trees *i.e.*, banana, *Musa* spp. (Musaceae); citrus, *Citrus* spp. (Rutaceae) and grape, *Vitis vinifera* L. (Vitaceae). Five samples

were taken from humid places near small irrigation canals at borders of the surveyed field and vegetable crops in the early morning before sunrise in absence of rains by using the quadrat sample size 50x50 cm² (Staikou *et al.*, 1990). Whereas, samples of fruit trees were collected by the same manner except snails were counted in 25 X 25 cm² on the soil and on one meter of the tree trunk near soil. Snails found on plants or on the soil surface in the quadrat were counted and transferred in tightly closed polyethylene bags to the laboratory for identification using a key given by Godan (1983) and Ali and Ramdane (2020).

Seasonal Population Behavior of *Monacha cartusiana* (Muller) on Certain Field and Vegetable Crops in Dakahlia Governorate

The conducted survey studied revealed that, the glassy clover snail *Monacha cartusiana* (Muller) is the most predominant gastropod species infesting major economic crops at Dakahlia governorate. Therefore, the seasonal population behavior of this snail was determined on two field crops i.e., Egyptian clover and wheat during two respective growing seasons 2019/2020 and 2020/2021. In this respect, an area of about one feddan (4200 m²) infested with *M. cartusiana* was selected for each crop at Burg El-Nour village, Aga district, Dakahlia governorate. Five replicates of quadrat sample size (50 x 50 cm²) were randomly examined at biweekly intervals during the growing season of each crop (Staikou *et al.*, 1988). The examination was undertaken in the early morning before sunrise in absence of rains. All snails found on plants or on soil surface in the quadrat were counted and left in their initial places (Baker, 1988). Data concerning temperature and relative humidity during the period of the study were obtained from meteorological station of El-Mansoura city. Obtained data were subjected to statistical analysis as correlation coefficient between snail numbers and each of temperature and relative humidity using (Costat, 2005).

RESULTS AND DISCUSSION

Ecological studies are very necessary to design successful programs to protect crops from damage caused by land gastropods as well

as other pests. To accomplish this goal, occurrence, population density and seasonal population behavior of the most predominant land gastropods were studied on the major crops at Dakahlia governorate during two successive growing seasons 2018 to 2020.

Incidence of Land Snails and Slugs Infesting Major Field, Vegetable and Fruit Crops in Dakahlia Governorate

Results of a survey carried out on gastropod fauna infesting major field, vegetable and fruit crops in 12 villages (localities) representing four districts of Dakahlia governorate revealed the occurrence of three land snail species and one slug species belonging to order: Stylommatophora. The snail species were, the glassy clover snail *Monacha cartusiana* (Muller) family: Hygromiidae, the brown garden (chocolate-band) snail *Eobania vermiculata* (Muller) family: Helicidae and the succineid snail *Succinea* sp., family: Succineidae, while the slug species was *Deroceras* sp., family: Agriolimacidae. The identified species varied in their incidence according to host plant, locality and season (Table 1). In this respect, *M. cartusiana* snail has the upper hand, since it was detected in most of all surveyed localities infesting the majority of examined crops. It was more abundant on field and vegetable crops compared to fruit trees. On contrary, *E. vermiculata* was found on all examined fruit crops. It was not detected on any of the studied field and vegetable crops at all surveyed localities. The succineid snail *Succinea* sp. was found on field and vegetable only, it was not observed infesting fruit crops. On the other hand, the slug *Deroceras* sp. was found in certain localities infesting all examined crops except wheat, broad bean and potato. Numbers of surveyed villages (localities) infested with *M. cartusiana* were relatively higher with field and vegetable crops as compared to those of fruit trees. For instances, among 12 surveyed villages, number of those infested with such snail were 10 on Egyptian clover and lettuce, 9 on cabbage and 8 on wheat, broad bean and potato. Whereas, numbers of villages infested with *M. cartusiana* on banana, citrus and grape were 4, 5 and 7 ones, respectively. Population density of *M. cartusiana* differed from host plant to another (Table 2). Among field and

Table 1. Occurrence of land gastropod species on major field, vegetable and fruit crops at Dakahlia Governorate

Districts	Localities (Villages)	Seasons	Field crops			Vegetable crops			Fruit crops		
			Egyptian Clover	Wheat	Broad Bean	Cabbage	Lettuce	Potato	Banana	Citrus	Grape
	Burg	2018/2019	M,S	M	M,S	M,S	M	M	M,E,D	-	M,E,D
	El-Nour	2019/2020	M,S	M	M,S	M	M	M	M,E,D	-	M,E
Aga	Meet Abou El-Hareth	2018/2019	M,S	M	M,S	M,S	M	M	-	M,E	M,E
		2019/2020	M,S	M	M,S	M	M	M	-	M,E	M,E
	Damas	2018/2019	0	0	S	S	M	0	D	E	E
		2019/2020	0	0	S	0	M	0	D	E	E
	El-Kordy	2018/2019	M,S,D	M,S	M	M	M,S	M	M,E,D	M,E	M,E,D
		2019/2020	M,S,D	M,S	M,S	M	M,D	M	M,D	M,E	M,E
Miniet	Meet Assem	2018/2019	M,S,D	M,S	M	M	M,S	M	-	M,E	-
El-Nasr		2019/2020	M,S,D	M,S	M,S	M	M,D	M	-	M,E	-
	Berenbal	2018/2019	M,D	0	0	0	M,D	0	0	E	D
		2019/2020	M,D	0	0	0	M	0	D	E	0
	Bosat Karam	2018/2019	M,S,D	M,S	M	M,D	M	M,S	M,E,D	M,E,D	M
		2019/2020	M,S,D	M,S	M	M,D	M,D	M,S	M,E,D	M,E	M
Sherbeen	El-Hisas	2018/2019	S	0	0	M,D	D	0	0	E	0
		2019/2020	S	S	S	M,D	0	0	D	E	0
	El-Sabriah	2018/2019	M,S,D	M,S	M	M,D	M	M,S	-	M,E	M,E
		2019/2020	M,S,D	M,S	M,S	M,D	M,D	M,S	-	E	M,E
	Batra	2018/2019	M,S	M,S	M	M,S	M,S	M,S	E	-	E
		2019/2020	M,S	M,S	M,S	M,S	M,S	M,S	M,E	-	M,E
Talkha	EL-Tawela	2018/2019	M,S	M,S	M	M,S	M,S	M,S	-	-	M,E
		2019/2020	M,S	M,S	M,S	M,S	M,S	M,S	-	-	M,E,D
	Goger	2018/2019	M	0	0	0	S	S	E	0	E
		2019/2020	M	S	S	0	S	S	E	0	E

Where; mixed infestation with two or more species were detected in certain counties, M = *Monacha cartusiana*, E = *Eobania vermiculata*, S = *Succinea* sp., D = *Deroceras* sp., 0 = No infestation and - = No plantations.

Table 2. Population density of *M. cartusiana* on major field, vegetable and fruit crops at Dakahlia Governorate

Districts	Localities (Villages)	Seasons	Field crops			Vegetable crops			Fruit crops		
			Egyptian Clover	Wheat	Broad Bean	Cabbage	Lettuce	Potato	Banana	Citrus	Grape
Aga	Burg	2018/2019	29.9	12.1	11.5	15.1	21.1	4.6	4.6	-	5.4
	El-Nour	2019/2020	25.6	11.2	7.8	13.0	19.5	8.8	5.2	-	5.4
	Meet Abou	2018/2019	25.0	12.0	14.9	13.3	17.6	15.5	-	6.3	5.3
	El-Hareth	2019/2020	14.3	8.0	5.5	10.1	17.2	6.9	-	6.3	5.3
	Damas	2018/2019	0	0	0	0	20.6	0	0	0	0
		2019/2020	0	0	0	0	14.2	0	0	0	0
El-Kordy	2018/2019	21.8	11.7	11.1	16.4	15.8	12.8	6.0	6.4	5.2	
	2019/2020	16.3	8.2	7.4	13.0	16.3	8.6	7.4	4.6	5.2	
Miniet	Meet Assem	2018/2019	18.3	12.7	8.5	16.6	14.3	8.1	-	5.0	-
El-Nasr		2019/2020	20.8	8.4	7.8	13.4	15.6	8.7	-	5.2	-
Berenbal	2018/2019	19.8	0	0	0	0	14.6	0	0	0	
		13.3	0	0	0	0	11.5	0	0	0	
	Bosat Karam	2018/2019	21.0	12.8	9.0	12.4	10.0	4.3	2.7	5.3	3.3
		2019/2020	17.6	9.1	8.2	11.7	16.0	7.8	4.2	5.2	4.0
Sherbeen	El-Hisas	2018/2019	0	0	0	10.2	0	0	0	0	0
		2019/2020	0	0	0	10.3	0	0	0	0	0
El-Sabriah	2018/2019	12.5	5.9	4.5	9.3	14.5	8.9	-	4.7	4.2	
		13.2	6.9	5.9	10.3	11.8	7.8	-	4.8	4.4	
Batra	2018/2019	27.7	15.2	11.2	15.0	24.4	10.8	0	-	-	
		23.2	13.6	10.7	12.2	22.5	9.7	5.9	-	5.6	
Talkha	El-Tawela	2018/2019	25.5	13.5	17.4	18.5	19.9	12.5	-	-	4.6
		2019/2020	23.4	13.1	10.8	13.8	15.1	10.5	-	-	6.5
Goger	2018/2019	24.0	0	0	0	0	0	0	0	0	
		2019/2020	17.5	0	0	0	0	0	0	0	0

Where; each value represents average number of snails per sample, mixed infestation with two or more species were detected in certain counties, 0 = No infestation and - = No plantations.

vegetable crops, Egyptian clover and lettuce gained the highest values while wheat and potato showed the lowest ones. Ranges of individuals on the aforementioned crops during 2018/2019 and 2019/2020 seasons were 12.5-29.9 (13.2-25.6), 10.0-24.4 (11.8-22.5), 5.9-15.2 (6.9-13.6) and 4.3-15.5 (6.9-10.8) snails per 50 X 50 cm², respectively. On the other hand, ranges of snail numbers on banana, citrus and grape trees were found to be lower during the two seasons with values 2.7-6.0 (4.2-7.4), 4.7-6.4 (4.6-6.3) and 3.3-5.6 (4.0-6.5) snails/sample, respectively. On the other hand, numbers of *M. cartusiana* differed from locality to another. Since, the highest numbers of this snail on Egyptian clover and lettuce were counted in Borg El-Nour village (Aga district) and Batra village (Talkha district) during 2018/2019 and 2019/2020 seasons with values 29.9, 25.6 (21.1, 19.5) and 27.7, 23.2 (24.4, 22.5) snails per sample, respectively.

Concerning the brown garden snail *E. vermiculata* on fruit trees, it was obvious that this snail was found on banana, citrus and grape with variable occurrence and population density (Table 3). It was encountered on citrus and grape in 8 villages compared to 5 villages on banana. The highest population densities were counted in Meet Abou El-Hareth village (Aga district) on citrus and grape during 2018/2019 and 2019/2020 seasons with values of 16.2 (17.8) and 14.8 (16.9) snails per sample, respectively. The succineid snail *Succinia* sp. was found infesting all surveyed field and vegetable crops in Dakahlia governorate with different incidence and population density (Table 4). It was found on broad bean in 10 villages followed by Egyptian clover in 9 villages and wheat in 8 villages while it was detected on cabbage, lettuce and potato in 5 villages. The highest population densities were found on Egyptian clover in Bosat Karam El-Deen (Sherbeen district) during 2018/2019 and 2019/2020 seasons with values of 16.2 and 18.9 snails per 50X50 cm², respectively. It is necessary to mention that incidence of this snail varied greatly according to season. For instances, on broad bean it was observed in three localities during 2018 /2019 season, whereas it was counted in 10 villages during 2019/2020 season gaining values ranged between 6.8 and 12.6 snails/sample in Borg El-Nour (Aga district) and Goger (Talkha district) during 2018/2019 and

2019/2020 seasons, respectively. Finally, *Deroceras* sp. was found on banana (6 villages), Egyptian clover and lettuce (5villages), citrus and grape (4 villages) and cabbage (3 villages) with a relatively low population density ranged between 4.5 slug per sample on Egyptian clover in El-Sabriah (Sherbeen district) and 13.4 slug on citrus in Damas (Aga district) during 2018/2019 and 2019/2020 seasons, respectively (Table 5).

These results agree to certain extent with those reported by many authors, who surveyed land molluscs at Dakahlia Governorate. They indicated that *M. cartusiana* was the most widely distributed species on field crops, especially Egyptian clover. Firstly, **Kady et al. (1983)** recorded *M. abstracta* in Egyptian clover fields at Agricultural Experimental Station of Mansoura University. **El-Deeb et al. (1996)** surveyed, *M. cartusiana*, *S. putris*, *E. vermiculata*, *C. acuta*, *C. nemoralis* on Egyptian clover, cabbage and other crops at Dakahlia governorate. **Mortada (2002)** identified 13 species of land gastropods included 9 snails and 4 slugs, *M. cartusiana* was the most prominent species, since it was found in all inspected localities of Dakahlia governorate infested all examined plants especially field and vegetable crops, whereas *S. putris* and *S. oblonga* were detected mainly on field and vegetable crops and finally, **Genena et al. (2014)** recorded for the first time four land snail species namely; *Allopeas clavulinum*, *Opeas pyrgula*, *Helicodiscus singleyanus inermis* and *Vallonia pulchella* associated with various ornamental plants at Mansoura district. On the other hand, in other governorates many authors showed that the glassy clover snail occupied the first grade in incidence with high level of infestation on the majority of the surveyed crops. Field and vegetable crops, were the most deleterious hosts. *E.vermiculata* was found on fruit crops only while the succineid snail *Succinea* sp. was detected on field and vegetable only. However, the slug *Deroceras* sp. was found in certain localities infesting all examined crops except wheat, broad bean and potato. These results were reported by many researchers who surveyed land molluscs on these crops (**Mahrous et al., 2002; Abd El-Aal, 2007; Mohamed, 2015; Ismail et al., 2017; Shahawy et al., 2018; Ali and Ramdane, 2020; Abo-Zaid, et al., 2021; Abd El-Halim et al., 2021; El-Kady et al., 2023**).

Table 3. Population density of *Eobania vermiculata* on major fruit crops at Dakahlia Governorate

Districts	Localities (Villages)	Fruit crops					
		Banana		Citrus		Grape	
		2018/2019	2019/2020	2018/2019	2019/2020	2018/2019	2019/2020
Aga	Burg El-Nour	12.8	12.1	-	-	12.4	13.4
	Meet Abou El-Hareth	-	-	16.2	17.8	14.8	16.9
	Damas	0	0	11.2	12.3	14.7	15.7
Miniet El-Nasr	El-Kordy	9.9	0	14.6	12.8	14.1	11.9
	Meet Assem	-	-	-	12.9	-	-
	Berenbal	0	0	12.8	13.3	0	0
Sherbeen	Bosat Karam El-Deen	9.7	12.1	12.5	12.9	-	-
	El-Hisas	0	0	8.8	13.1	0	0
	El-Sabriah	-	-	12.0	12.3	12.2	11.9
Talkha	Batra	11.2	13.2	-	-	13.8	14.1
	El-Tawela	-	-	-	-	11.7	12.9
	Goger	13.0	12.4	0	0	11.9	12.6

Where; each value represents average number of snails per sample, mixed infestation with two or more species were detected in certain counties, 0 = No infestation and - = No plantations.

Table 4. Population density of *Succinia* sp. on major field and vegetable crops at Dakahlia Governorate

Districts	Localities (Villages)	Field crops						Vegetable crops					
		Egyptian Clover		Wheat		Broad Bean		Cabbage		Lettuce		Potato	
		2018 2019	2019 2020	2018 2019	2019 2020	2018 2019	2019 2020	2018 2019	2019 2020	2018 2019	2019 2020	2018 2019	2019 2020
Aga	Burg El-Nour	11.2	13.3	0	0	5.5	6.8	9.7	0	0	0	0	0
	Meet Abou El-Hareth	12.3	13.9	0	0	6.6	8.7	10.8	0	0	0	0	0
	Damas	0	0	0	0	7.7	8.9	11.7	0	0	0	0	0
Miniet El-Nasr	El-Kordy	13.8	15.1	7.2	9.8	0	6.9	0	0	11.9	0	0	0
	Meet Assem	12.0	14.0	6.2	7.8	0	7.8	0	0	12.7	0	0	0
	Berenbal	0	0	0	0	0	0	0	0	0	0	0	0
Sherbeen	Bosat Karam El-Deen	16.2	18.9	10.0	12.8	0	0	0	0	0	0	7.6	8.8
	El-Hisas	14.1	15.7	0	13.3	0	8.7	0	0	0	0	0	0
	El-Sabriah	14.8	15.8	12.2	14.2	0	9.8	0	0	0	0	6.6	8.7
Talkha	Batra	12.5	13.5	10.2	11.3	0	10.7	11.9	12.1	10.9	11.8	9.5	11.5
	El-Tawela	16.2	17.8	12.5	16.7	0	11.1	14.2	16.6	15.9	16.5	11.5	12.4
	Goger	0	0	0	12.5	0	12.6	0	0	14.3	15.9	12.9	13.1

Where; each value represents average number of snails per sample, mixed infestation with two or more species were detected in certain counties, 0 = No infestation and - = No plantations.

Table 5. Population density of *Deroceras* sp. on major field, vegetable and fruit crops at Dakahlia Governorate

Districts	Localities (Villages)	Egyptian Clover		Cabbage		Lettuce		Banana		Citrus		Grape	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
		2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
	Burg El-Nour	0	0	0	0	0	0	11.8	12.6	-	-	11.9	0
Aga	Meet Abou El-Hareth	0	0	0	0	0	0	-	-	0	0	0	0
	Damas	0	0	0	0	0	0	11.7	9.9	0	13.4	0	0
	El-Kordy	9.8	10.3	0	0	0	9.7	10.7	11.8	0	0	12.6	0
Miniet El-Nasr	Meet Assem	8.9	9.9	0	0	0	8.7	-	-	0	0	-	-
	Berenbal	6.8	7.9	0	0	9.8	0	0	11.9	0	0	13.0	0
	Bosat Karam El-Deen	3.5	5.5	4.5	5.9	0	7.5	7.8	11.5	6.0	0	9	0
Sherbeen	El-Hisas	0	0	6.2	76	8.2	0	0	12.4	8.7	0	0	0
	El-Sabriah	4.5	6.5	8.3	8.9	0	6.8	-	-	0	0	0	0
	Batra	0	0	0	0	0	0	0	0	-	-	0	0
Talkha	El-Tawela	0	0	0	0	0	0	-	-	-	-	-	10.6
	Goger	0	0	0	0	0	0	0	0	9.7	-	0	0

Where; each value represents average number of snails per sample, mixed infestation with two or more species were detected in certain counties, 0 = No infestation and - = No plantations.

Moreover, **El-Okda (1981)**, reported that the active dispersal capabilities of *M. cartusiana* may be due to a relatively higher environmental tolerance, fecundity and adaptability to the new habitats. **Ibrahim et al., (2017)** indicated that the economic damage threshold of *M. cartusiana* on strawberry plants ranged 2-2.5 snail/plant while economic injury level ranged 3-7.5 snail/plant.

Seasonal Population Dynamics of *M. cartusiana* on Egyptian Clover and Wheat In Borg El-Nour Village, Aga District, Dakahlia Governorate

Survey studies showed that *M. cartusiana* snail was the predominant species since it was detected in most of surveyed localities, with moderate to high population density on most of the examined hosts. Therefore, the population dynamics of this snail were studied on Egyptian clover and wheat in Borg El-Nour village, Aga district, Dakahlia Governorate during two successive growing seasons 2019/2020 and 2020/2021. Data in Table 6 showed that the initial infestation of *M. cartusiana* has appeared

at the beginning of November on Egyptian clover with population densities of 5.3 and 7.6 snail per quadrat size of 50 x 50 cm² in the growing seasons 2019/2020 and 2020/2021, respectively. While on wheat the initial infestation was appeared later at the beginning of January with relatively lower population densities of 3.9 and 3.7 snails per sample in the two successive seasons, respectively. Snails were not detected on wheat during December. Monitoring the population behavior of *M. cartusiana* after the initial infestation, it was clear that the snail numbers were slightly increased during December and January months. However, in February snail numbers were noticeably increased to reach their peak in mid-April with values of 26.5 and 20.7 and 9.5 and 9.4 snails per sample on Egyptian clover and wheat for the two successive growing seasons, respectively. However, the population density of the snail was obviously decreased during May on Egyptian clover in the two seasons. The numbers of snails per sample at the end of the growing seasons on Egyptian clover (mid-May) were 20.2 and 18.0 snails, respectively. While the parallel values on wheat (mid-April)

Table 6. Seasonal fluctuation of *M. cartusiana* on certain field crops at Dakahlia Governorate

Date	Average numbers of <i>M. cartusiana</i> per 50X50 cm ²							
	Egyptian Clover		Wheat		Temp. C°		R.H.%	
	2019 2020	2020 2021	2019 2020	2020 2021	2019 2020	2020 2021	2019 2020	2020 2021
Nov.1	5.3	7.6	-	-	21.4	25.7	67.3	55.1
Nov.16	6.6	7.8	-	-	20.8	18.0	53.5	66.1
Dec.1	9.8	10.2	0	0	16.4	17.1	58.8	55.1
Dec.16	10.8	10.8	0	0	13.9	16.8	58.9	61.6
Jan.1	12.9	12.4	3.9	3.7	13.6	17.5	62.7	68.2
Jan.16	12.9	13.2	4.2	5.1	17.0	15.2	47.0	54.6
Feb.1	14.5	13.4	6.9	8.2	15.9	15.2	49.8	61.2
Feb.16	14.6	13.6	7.4	7.9	19.6	18.3	40.1	54.8
Mar.1	17.8	14.4	9.0	9.4	20.6	20.5	46.3	47.0
Mar.16	21.1	16.6	9.1	9.5	20.1	20.8	47.9	58.0
Apri.1	24.6	18.8	9.3	10.6	12.4	20.8	34.8	47.4
Apri.16	26.5	20.7	9.5	9.4	21.7	23.9	46.5	47.1
May.1	22.3	21.8	-	-	25.3	25.4	46.1	41.7
May.16	20.2	18.0	-	-	28.0	28.3	46.5	48.67
Total	219.9	199.3	59.3	63.8				
Average	15.71	14.24	5.93	6.38				

Where; each value represents average number of snails per sample, mixed infestation with two or more species were detected in certain counties, 0 = No infestation and - = No plantations.

were 9.5 and 9.4 snails/sample in the two growing seasons, respectively. It is necessary to mention that, Egyptian clover harbored a relatively higher number of snails compared to wheat. Total numbers of counted snails on Egyptian clover and wheat were 219.9 and 199.3 and 59.3 and 63.8 in the two successive growing seasons, respectively. While the parallel general means were 15.71 and 14.24 and 5.93 and 6.38, respectively. Generally, it could be concluded that the population density of *M. cartusiana* increased during the spring months as compared to low or moderate values during the autumn and winter months. This conclusion is in agreement with the findings of **Mahrous et al. (2002)** and **Ismail et al. (2017)** who found that the population density of *M. cartusiana* was

obviously increased during spring months (March, April, and May) as compared to low or moderate values during winter and autumn months at Sharkia governorate. The infestation did not appear during the summer months. Moreover, **Mohamed (2017)** showed that Egyptian clover harbored the highest number of *M. cartusiana* followed by wheat and population density was obviously increased during February, March and April months as compared to the other months.

The correlations between some climatic factors *i.e.*, temperature or relative humidity and population density of *M. cartusiana*. were subjected to statistical analysis. Data presented in Table 7 revealed that temperature showed an insignificant positive effect on the numbers of

Table 7. Simple correlation coefficient (r) values between temperature and relative humidity with population size of *M. cartusiana* infesting Egyptian clover and wheat during two successive growing seasons at Dakahlia Governorate

Host Plant	Temp. C°		R.H. %	
	2019/2020	2020/2021	2019/2020	2020/2021
Egyptian clover	0.296 ^{n.s}	0.489 ^{n.s}	- 0.368 ^{n.s}	- 0.609*
Wheat	0.266 ^{n.s}	0.062 ^{n.s}	- 0.293 ^{n.s}	- 0.157 ^{n.s}

Where; each digit represents correlation coefficient, ^{n.s} = (Not significant) at level of (0.05), and* = Significant at level of (0.05).

M. cartusiana during the two successive seasons on Egyptian clover and wheat. Regarding the effect of relative humidity on the population density of such snail, it was found that an insignificant negative effect was detected on Egyptian clover and wheat with correlation coefficient values of -0.368 and -0.293 during the first season 2019/2020, respectively. However, during the second season (2020/2021) relative humidity significantly negatively correlated with population density of *M. cartusiana* on Egyptian clover (- 0.609*) and insignificantly negatively correlated on wheat (-0.157). The obtained results agree to a certain extent with those reported by **Mohamed (2017)** who revealed that temperature showed an insignificant effect on numbers of *M. cartusiana* during two successive seasons on Egyptian clover and wheat. On the other hand, the effect of relative humidity on population density showed an insignificant or significant negative effect on the numbers of *M. cartusiana* during two successive seasons on the two crops.

In the literature, there were inconstant results concerning the correlation between temperature or relative humidity and population density of *M. cartusiana* in Egypt. For instances, on Egyptian clover values of the correlation coefficient between temperature and population density were differed from locality to another and from season to another. For example, in Sharkia governorate, **Ismail (1997)** reported that temperature gave insignificant and significant positive effect on density of *M. cartusiana* during seasons 1993/1994 and 1994/1995 respectively. **Mahrous et al, (2002)** showed that temperature gave significant and highly significant positive

effect during 1998/1999 and 1999/2000, respectively. **Mohamed (2017)** revealed that temperature showed insignificant negative and positive effect during 2014/2015 and 2015/2016, respectively. On the other hand, **Mortada, (2002)** reported that temperature showed insignificant positive or negative effect during 1997/1998 and 1998/1999 in Dakahlia governorate. **Abo-Zaid et al., (2021)** revealed that temperature showed an insignificant negative effect on the numbers of *M. cartusiana* during the two successive seasons 2016/2017 and 2017/2018 in Gharbia governorate.

Generally, there is no definite correlation between temperature or relative humidity and population dynamic of *M. cartusiana* during the two successive seasons. **Moreno-Rueda et al., (2009)** reported that terrestrial snails can respond to adverse weather by selecting the suitable microhabitat for their survival. The importance of temperature or relative humidity on the use of microhabitat differed geographically, relative humidity is more important than temperature in arid zones.

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التواجد والكثافة العددية وديناميكية التعداد الموسمي للقواقع الأرضية التي تصيب المحاصيل الرئيسية

في محافظة الدقهلية ، جمهورية مصر العربية

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أظهرت نتائج الحصر الذى اجرى على البطنقدمات الارضية التي تصيب محاصيل الحقل والخضر والفاكهة الرئيسية فى 12 قرية (موقع) تمثل اربع (مراكز) فى محافظة الدقهلية خلال فترة النشاط الموسمي لانواع البطنقدمات الارضية اثناء موسمين زراعيين متتاليين 2019/2018 & 2020/2019 ، عن تواجد ثلاثة أنواع من القواقع الارضية ونوع واحد من البزاقات التابعة لرتبة طرفية العيون ، وكانت القواقع : هى قوقع البرسيم الزجاجى وقوقع الحدائق البنى (الشيكولاتى المخطط) وقوقع السكسينيا أما البزاقة فهى تابعة للجنس ديروسيراس ، وقد اختلف تواجد هذه الانواع على حسب العائل النباتى والمكان والموسم وكان لقوقع البرسيم الزجاجى اليد العليا فى هذا الصدد حيث تم تسجيله فى معظم الاماكن التى تم حصرها وعلى غالبية المحاصيل التى دراست ، وبصفة خاصة محاصيل الحقل والخضر مقارنة باشجار الفاكهة فى حين تواجد قوقع الحدائق البنى على جميع محاصيل الفاكهة ولم يتم تسجيل تواجده على اى من محاصيل الحقل أو الخضر وعلى العكس من ذلك تواجد قوقع السكسينيا على محاصيل الحقل والخضر ولم يتم تسجيله على اشجار الفاكهة، ومن ناحية أخرى وجدت البزاقة فى اماكن محددة وعلى جميع المحاصيل التى درست عدا القمح والفول والبطاطس. وعلى الجانب الاخر فقد اختلفت الكثافة العددية لقوقع البرسيم الزجاجى من عائل الى اخر ومن موقع الى اخر ومن بين محاصيل الحقل والخضر حصل البرسيم والخس على اعلى القيم فى حين حصل القمح والبطاطس على اقلها ، وكانت أعلى قيم للكثافة العددية لهذا القوقع على البرسيم والخس فى قرية برج النور (مركز أجا) ، وقرية بطرة (مركز طلخا) خلال الموسمين 2019/2018 & 2020/2019 مسجلة قيم مقدارها 29.9 و 25.6 و (21.1 و 19.5) & 27.7 و 23.2 و (24.4 و 22.5) قوقع لكل 50 سم² على التوالي ، فى حين سجلت الانواع الاخرى نسب تواجد وكثافة عددية اقل نسبيا على المحاصيل المصابة ، وقد تم متابعة سلوك التعداد الموسمي لقوقع البرسيم الزجاجى على البرسيم والقمح خلال موسمين متتاليين (2020/2019 & 2021/2020) واتضح زيادة الكثافة العددية خلال اشهر الربيع مقارنة بقيم منخفضة او متوسطة خلال اشهر الخريف والشتاء.

الكلمات الإسترشادية: البطنقدمات الارضية، قوقع البرسيم الزجاجى، التواجد، الكثافة العددية، سلوك التعداد، محافظة الدقهلية.

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