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Population dynamics of land gastropods on different crops in Qalyubia Governorate, Egypt

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Abstract

Land snails are a deleterious agricultural pest on economic crops, although the populations of these pests are influenced by abiotic and biotic factors, which affect their behavior, distribution and population dynamics. For these reasons, researchers should follow the changes in their behavior, distribution, and population dynamics. In this research, a survey was performed to define land snail species present at Qalyubia Governorate, Egypt, through the seasonal activity period of gastropod species during two consecutive growing seasons (2023/2024 and 2024/2025). A survey was conducted on land gastropods infesting major fields, vegetable, ornamental, and fruit trees in four regions (localities) representing four districts (Counties) to study the population dynamics for the dominant land snail species. Of Qalyubia Governorate. The results showed the presence of three land snails. Three snail species were identified: the brown garden (chocolate-band) snail *Eobania vermiculata* (Muller) (Gastropoda: Helicidae)the glassy clover snail *Monacha obstructa* (Muller) (Gastropoda: Hygromiidae) and the snail *Cochlicella acuta* (Muller) (Gastropoda: Cochlicellidae). The identified species varied in their incidence according to host plant, region, and season. In this regard, *M. obstructa* snail has the upper hand, since it was identified in most of all studied territories, overrunning the lion's share of inspected crops. It was more plenteous on field and vegetable crops, with the clover the highest number of *M. obstructa*, followed by lettuce, cabbage, wheat, and broad been, compared to fancy plants orange trees. *E. vermiculata* was found on all inspected decorative plants and orange trees. It was not recognized in any of the fields examined or vegetable crops in any of the studied territories. In the same trends, the seasonal fluctuation of *M. obstructa* on clover crop and the land snail *M. obstructa* recorded population density of the land snail is increasing gradually after winter until it reaches the maximum density in spring.

Introduction

In recent decades, the significance of land gastropods, including snails, as animal pests has grown substantially (Gathwaite and Thomas, 1996, and Haszprunar, 2020). Snail populations have grown substantially and have become significant pests, leading to considerable damage, particularly to horticultural crops (Heikal, 2015). Land gastropods pose a substantial threat to sustainable crops across various regions globally (Speiser and Kistler, 2002; Schweizer *et al*., 2019; Barker, 2002; Flint, 2011; and Baker, 2012). The damage inflicted by these species occurs not only through their direct feeding on economically valuable crops but also through contamination from their bodies, slime, or feces. This ultimately results in a decline in both the quality and quantity of the products (Iglesias *et al*., 2003, and Heiba *et al*., 2018). Its movement produces an unpleasant odor that may deter both humans and farm animals from consuming these crops (El-Okda, 1984; Sallam *et al*., 2009; and Abo Zaid *et al*., 2021). Numerous species of these snails have been documented across various governorates in Egypt, as noted by Eshra in 2014; Eshra *et al*., 2015; Abou Senna *et al*., 2016; and Ali and Robinson, 2020.

The objective of the present study is to study the occurrence of terrestrial gastropods on the major economic fields, vegetable and fruit crops, in three districts in Qalyubia governorate and to study the seasonal population behavior of the most predominant terrestrial snail, *Monacha obstructa* (Muller) (Gastropoda: Hygromiidae) on certain field crops. To gather key information about snails that can be effectively and safely applied in integrated pest management (IPM) strategies to control these pests across different crops in field environments.

Materials and methods

1. Occurrence of land snails infesting different crops in Qalyubia Governorate:

This work has been executed in four regions at Qalyubia governorate, i.e., Banha, Toukh, Shubra El Kheima, and Al-Qanatir Al-Khayriyyah, through the activity period of terrestrial snail during two successive growing seasons, 2023/2024 and 2024/2025. The survey was conducted on field crops, i.e., Egyptian clover, wheat, and broad beans, besides vegetable crops, i.e., cabbage and lettuce, as well as fruit trees, i.e., citrus. Five samples were taken from places near the borders of the surveyed field and vegetable crops in the early morning in the absence of rain by using the quadrate sample size of 50x50 cm^2 (Staikou *et al*., 1990). Whereas samples of trees were collected in the same manner except for the quadrate sample size of 25 X 25 cm^2 on the soil and on one meter of the tree trunk near the soil. Snails found on plants or on the soil surface in the quadrate were counted and transferred in tightly closed canvas bags to the laboratory for identification using a key given by Godan (1983) and Ali and Ramdane (2020).

2. Seasonal behavior of *Monacha obstructa* on definite field and vegetable crops at Qalyubia Governorate:

The survey carried out disclosed at Qalyubia Governorate: The clover snail, scientifically known as *M. obstructa*, stands out as the most prevalent gastropod species wreaking havoc on significant economic crops in the Qalyubia Governorate. Therefore, the seasonal population dynamic of this snail was determined on three field crops, i.e., Egyptian clover, wheat, and beans, during two respective growing seasons 2023/2024, and 2024/2025. In this regard, an area of 24 qirat of land was chosen (one feddan) infested with *M. obstructa* was selected for each crop

at Banha district, Qalyubia governorate. Five replicates of a quadrate sample size (50 x 50 cm^2) were randomly examined at biweekly intervals during the growing season of each crop (Staikou *et al*., 1988). The examination was assumed in the early morning in the absence of rain. All snails found on plants or on the soil surface in the quadrate (50 x 50 cm^2) were counted and left in their places (Baker, 1988). Data concerning temperature and relative humidity during the period of the work were obtained from the Central Climate Laboratory of Dokki, Giza, Egypt. Statistical analysis of the data obtained was carried out using the correlation coefficient between the number of snails and each of the temperature and humidity using the program (Costat, 2005).

Results and discussion

Ecological studies are essential to designing effective programs to protect crops from harm caused by land snails. To achieve this target, the incidence, population density, and seasonal population behavior of the most dominant land gastropods on main crops at Qalyubia Governorate were investigated during two consecutive growing seasons from 2023 to 2025**.**

1. Occurrence of land snails and infestation of different crops at Qalyubia Governorate:

Obtained results of a survey carried out on mollusca fauna infesting major plantations (Field crops, vegetables, orchards, and ornamental plants) in four regions of Qalyubia Governorate revealed the occurrence of three land snail species: the glassy clover snail *Monacha obstructa* (Muller), the brown garden snail *Eobania vermiculata* (Muller) (Gastropoda: Helicidae)and the snail *Cochlicella acuta* (Muller) (Gastropoda :Cochlicellidae). The identified species varied in their incidence according to host plant, (Table 1). In this regard, *M. obstructa* snail is the dominant one, since it was recorded in all surveyed localities, infesting the majority of tested crops. There were more plenty on field and vegetable crops compared to citrus trees and ornamental plants.

On the contrary, *E. vermiculata* was found on all examined citrus trees. It was not detected in any of the fields studied or in any of the vegetable crops at all surveyed localities. On the other hand, the snail *C. acuta* was found on ornamental plants only; it was not observed in the infesting field and vegetable crop, or the examined citrus tree. The population density of *M. obstructa* varied across different host plants (Table 2).

Inter alia, of the field and vegetable crops studied, Egyptian clover, lettuce, and cabbage exhibited the highest population densities, whereas wheat and broad bean recorded the lowest densities. Ranges of populations of snails on the aforementioned crops during the 2023/2024 and 2024/2025 seasons were 28-32.4 (26.2-30), 14.2-16.2 (13.6-18), 13, 14.8 (11.8-12.8), 11.4-13 (10.2-12.4), and 9.8-12.8 (5.4-9.4) snails/ (50 X 50 cm^2), respectively. Concerning the *C. acuta* low population density was recorded during the first and second seasons with values of 0.0 and 6.8 (0.0-5.2) snails/ sample, respectively.

Data presented in Table (3) revealed that the infestation of the brown garden snail *E. vermiculata* on fruit trees was obvious; the snail was found on citrus. The recorded population density during the 2023/2024 and 2024/2025 seasons was 9.2, 11.8, 10.6, and 16 snails per sample, respectively. Additionally, the population of this snail on ornamental plants was meticulously tallied in Shubra El Kheima across the two seasons previously noted, with values of 20.8 and 25.3 snails per sample, respectively. This data agrees to a certain extent with those recorded by

many researchers, who surveyed land gastropods in many governorates. They indicated that *Monacha cartusiana* (Muller) (Gastropod: Hygromiidae) snail is the dominant occurrence species on field crops, especially Egyptian clover. Firstly, Kady *et al.* (1983) reported *M. obstracta* in Egyptian clover fields at the Agricultural Experimental Station of Mansoura University. El-Deeb *et al.* (1996) surveyed *M. cartusiana, E. vermiculata,* and *C. acuta,* on Egyptian clover cabbage, and other crops at Dakahlia Governorate. Khidr *et al*. (2020) surveyed *E. vermiculata* in orange trees at Qalyubia and Sharkia Governorate. Mortada (2002) reported that *M. cartusiana* was the most dominant species, since it was found in all inspected areas and infested with all examined plants, especially field and vegetable crops. On the other hand, many authors showed that the glassy clover snail occupied the first grade in incidence with a high level of infestation on the majority of the surveyed crops. Field and Vegeta hand, many were the most deleterious hosts. *E. vermiculata* was found on fruit crops only. These results were reported by many authors who surveyed land gastropods on these crops, such as 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 and El-Kady *et al*., 2023). In addition, El-Okda (1981) expressed that the higher dispersal abilities of *M. cartusiana* could be attributed to its relatively high environmental tolerance, adaptability to new habitats, and fecundity.

Table (1): Presence of land snails infesting different crops at Qalyubia Governorate.

Location	Examination data	Species	Host plant
Touch	2023/2025	*Monacha obstructa*	Clover+++, wheat^{+}, cabbage+++ bean+, orange trees+
		Eobania vermiculata	Orange trees+++
Al Qanatir Alkhayriyyah	2023/2025	*Monacha obstructa*	Clover^{+++}, bean^{++}, lettuce^{+++}
Banha	2023/2025	*Monacha obstructa*	Clover^{+++}, wheat^{++}, bean^{++}, lettuce^{+++} cabbage+++ , Grape^{+}
		Eobania vermiculata	Ornamental plants^{++}, orange trees+++
Shubra El Kheima	2023/2025	*Eobania vermiculata*	Ornamental plants^{+++}
		Monacha obstructa	Ornamental plants^{+}
	2023/2024	*Cochlicella acuta*	0.0
	2024/2025	*Cochlicella acuta*	Ornamental plants+

(0) = No infestation, (+) = Light infestation (less than 15 snails), (++) = Moderate infestation (between 15-30 snails), (+++) = Heavy infestation (more than 30 snails).

Table (2): Population density of *Monacha obstructa* on major fields, vegetable, and fruit crops at Qalyubia Governorate.

Regions	Examination data	Field crops			Vegetable crops		Fruit trees
		Egyptian clover	Wheat	Broad been	Cabbage	Lettuce	Citrus
Touch	2023/2024	32.4	11.4	9.8	14.8	16.2	4
	2024/2025	30	10.2	6.4	12.4	18	5.2
Al Qanatir Alkhayriyyah	2023/2024	29.8	12.2	12.8	13	14.2	0
	2024/2025	24.8	11	5.4	11.8	15.8	0
Banha	2023/2024	28	13	10.2	14.2	16	6.8
	2024/2025	26.2	12.4	9.4	12.8	13.6	4.6

Table (3): Population density of *Eobania vermiculata* on orange trees (fruit crop) at Qalyubia Governorate.

Regions	Citrus		Ornamental plants	
	Examination data			
	2023/2024	2024/2025	2023/2024	2024/2025
Touch	11.8	16	-	-
Banha	9.2	10.6	-	-
Shubra El Kheima	-	-	20.8	25.3

(-) = No plantations

2. Population Dynamics of *Monacha obstructa* on different crops in regions, Qalyubia Governorate.

The snail, *M. obstructa*, was recorded in all surveyed localities, with moderate to high population density on most of the examined host plants. Therefore, the population dynamics of *M. obstructa* were studied on Egyptian clover, beans, and wheat in Banha district, Qalyubia Governorate, during two consecutive growing seasons, 2023 to 2025.

Results presented in Table 4 revealed that infestation of *M. obstructa* had started in November on Egyptian clover with low population densities of 3.8 and 3.2 snails per sample during seasons 2023/2024 & 2024/22025, respectively. Monitoring the behavior, it turns out the snail count was slightly increased during December and January. But regarding broad beans and wheat, the initial snail infestation appeared at the beginning of January: it showed low population densities of 0.8, 1.2, 1.8, and 2.8 snails per sample in the two consecutive seasons, respectively. However, in February snail numbers were noticeably increased to reach their peak in mid-March with values of 43.6 and 46.4, 12.4 and 14, 20.4, and 15.2 snails per sample on Egyptian clover, bean, and wheat for the two successive growing seasons, respectively. During May of both growing seasons, there was a noticeable decrease in the population density of snails on Egyptian clover. By mid-May, the number of snails on Egyptian clover had reduced to 1.8 and 1.6 snails per sample, respectively. It's essential to note that Egyptian clover hosted a noticeably larger population of snails than bean and wheat. During the two consecutive growing seasons, the total number of snails counted on Egyptian clover, bean and wheat was 263.6 and 288.9, 49 and 56.7, and 69.8 and 67.2 in the two successive seasons, respectively.

The average values across these periods were 18.8 and 20.64 for Egyptian clover, and 3.5 and 4.05 for bean, and 4.98 and 4.8 for wheat, respectively. It can generally be concluded that the population density of *M. obstructa* tends to rise during the spring months, compared to the lower or moderate values observed in autumn and winter. The results align with studies by Mahrous *et al*. (2002) and Ismail *et al*. (2017), which observed a notable increase in the population density of *M. cartusiana* during spring months, specifically March and April, at Sharkia Governorate. During winter and autumn months, the figures remained low to moderate, while no infestation was noted throughout the summer months. Furthermore, Mohamed (2017) found that Egyptian clover supported the largest numbers of *M. cartusiana*, followed by wheat, with a significant rise in population density during February, March, and April compared to other months.

Table (4): Seasonal fluctuation of *Monacha obstructa* on certain field crops at Qalyubia Governorate.

Month Crop	Qalyubia Governorate Average number of snails /samples						Temp. (°C.)		RH. (%)	
	Clover		Bean		Wheat					
	2023/ 2024	2024/ 2025	2023 / 2024	2024 / 2025	2023/ 2024	2024 / 2025	2023 / 2024	2024 / 2025	2023 / 2024	22024 / 2025
November 1	3.8	**3.2**	0.0	0.0	0.0	0.0	24.87	21.4	63.55	58.8
November 15	8.6	6.1	0.0	0.0	0.0	0.0	19.72	20.9	61.87	65.8
December 1	10.4	8	0.0	0.0	0.0	0.0	17.67	17	62.04	67.5
December 15	12.6	15.2	0.0	0.0	0.0	0.0	17.17	15.6	71.07	59.2
January 1	13.4	18.6	0.8	1.2	1.8	2.8	14.49	14.4	67.32	70
January 15	14.8	23.6	1.1	2.6	2.6	3.2	14.72	15.6	58.83	48.8
February 1	23.2	29.8	3.2	3.8	4.2	5.4	12.62	14.5	71.98	72.8
February 15	29.8	35.8	3.8	4.6	6.8	5.8	14.81	13.6	65.97	64.6
March 1	39.8	38.6	11.8	10.2	14.2	10.8	17.15	14.9	61.46	63.8
March 15	43.6	46.4	12.4	14	20.4	15.2	18.31	21.9	55.41	53
April 1	37.8	36.2	9.8	10.2	12.6	12.8	21.69	21.7	55.99	26.4
April 15	20.2	19.8	6.1	10.1	7.2	11.2	24.70	20.5	46.46	44.4
May.1	3.8	6	0.0	0.0	0.0	0.0	23.80	22	49.08	43.7
May.15	1.8	1.6	0.0	0.0	0.0	0.0	27.87	25.1	38.33	43.5
Total	263.6	288.9	49	56.7	69.8	67.2				
Mean	18.8	20.64	3.5	4.05	4.98	4.8				

Table (5): Correlation coefficient (r) values between temperature, relative humidity, and the population size of *Monacha obstructa* infesting Egyptian clover and wheat across two consecutive seasons in Qalyubia Governorate.

Host plants	Factors	2023/2024				2024/2025			
		r	P	b	EV%	r	P	B	EV%
Bean	**Temp.**	-0.094	0.749	-0.482	9.49	0.054	0.855	-0.367	14.81
	RH. %	-0.102	0.729	-0.237	0.00	-0.323	0.261	-0.191	0.00
Clover	**Temp.**	-0.384	0.176	-2.11	20.48	-0.370	0.193	-2.71	27.36
	RH. %	0.161	0.582	-0.586	6.02	-0.036	0.904	-0.552	14.15
Wheat	**Temp.**	-0.146	0.617	-0.819	13.07	0.018	0.951	-0.503	17.23
	RH. %	-0.083	0.799	-0.375	0.00	-0.325	0.258	-0.231	2.19

The correlation coefficient between the population of *M. obstructa* and certain climatic factors was presented in Table (5), which indicates that the population of the tested snail on bean, clover, and wheat plants insignificantly correlated with both temperature and relative humidity during the two seasons of investigation. Data indicated that temperature and relative humidity had a relatively low impact on the population occurrence of *M. obstructa* on the three tested crops. Temperature showed a trivial negative effect on the total number of *M. obstructa* on the three crops (Bean, clover, and wheat), recording correlation coefficients of -0.094, -0.384, and -0.146 during the first season of 2023/2024, respectively. But, during the second season (2024/2025), the reverse took place (Temperature exhibited a substantial positive effect on the aggregation of *M. obstructa* on bean and wheat crops, showing correlation coefficients of 0.054 and 0.018, respectively). On the other side, relative humidity showed a positive influence on the population of snails on clover crops only (r = 0.161) during the first season (2023/2024), whereas during 2024/2025, it showed negative influences, recording correlation coefficients of -0.323, -0.036, and -0.325 on the three crops.

The attained outcomes align somewhat with those described by Mohamed (2017), who indicated that temperature demonstrated a negligible impact on counts of *M. cartusiana* throughout two consecutive seasons on Egyptian clover and wheat. Conversely, the impact of relative humidity on

population density exhibited negligible or significant negative influence on the numbers of *M. cartusiana* over two successive seasons on the two crops. So also, Mortada (2002) shared bits of knowledge from the Dakahlia governorate, noticing that temperature fizzled to illustrate any noteworthy way, whether positive or negative, during a long time, 1997/1998 and 1998/1999. In addition to this, Abo-Zaid *et al*. (2021) displayed discoveries from Gharbia Governorate, where temperature was however, once more found to play an unimportant part, appearing to have an unimportant negative impact on the populace of *M. cartusiana* over two continuous seasons: 2016/2017 and 2017/2018. The relationship between climatic components (temperature and relative mugginess) and populace thickness of snails (*M. obstructa*) was capricious relationship or an inconstant relationship (Abed, 2017). Also, Abd-Elhaleim *et al*. (2022) detailed that the rate and invasion level of arriving snails shifted according to climatic figures and locality. 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 suitable microhabitat for their survival. The importance of temperature or relative humidity on the use of microhabitats differs geographically, relative humidity is more important than temperature in arid zones.

The population dynamics and month-to-month thickness of earthly snails are the pillar and center to set up a fruitful bother control program against this agrarian bother. Subsequently, these inquiries present the basic database of earthly snails' populace energetics and the relationship with temperature and stickiness as climatic components on snails' populace thickness all through the season. The action periods of this bother have, moreover, been decided. This information will help the producers in envisioning a perfectly suitable control program to diminish the invasion level or dispense with the bug number. The oddity of this information helps to get snails' behavior beneath diverse climatic conditions in the Governorate.

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