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Movement and seasonal activity of land snails *Theba pisana* and *Eobania vermiculata* (Gastropoda: Helicidae) on citrus orchards at Qalubiya and Sharkia Governorates

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Abstract:

Horizontal and vertical dispersals of the land snails, white garden snail, *Theba pisana* (Müller) and brown garden snail *Eobania vermiculata* (Müller) (Gastropoda: Helicidae) were investigated in citrus orchards cultivated at Hod Elfadel, Almohamdia, Minya Al-Qamh district, Sharkia Governorate that had an heavy infested with different types of weeds; also, Shoubra Hars, Toukh district, Qalubiya Governorate during the growing season 2018/2019. Reverse relationship was found between abundance density and distance increasing. In vertical distribution, the abundance density of snails decreased by distances increasing on orange trees. Furthermore, spring season harbored the highest population densities followed by summer and winter. The same trend was observed for the horizontal distribution where abundance densities decreased by increasing distances.

Introduction

The Gastropoda is the only molluscs class of successfully invaded land that are a widely dispersal by human activity, mostly in association with movement of soil and plant materials. In the last few years, land snails have been increased and many species were recorded in the majority of governorates (Ghamry *et al*., 1993; El-Deeb *et al*., 1997; El-Masry, 1997; Ismail, 1997; Arafa, 2006 and Abed, 2017). Differs of dispersal, movement and daily activity of land snails from one species to another; it is influenced by environmental factors such as soil conditions, food supply temperature, light intensity and humidity. During adverse climatic conditions and drought times, the snails close the shell aperture with a mucus flap that hardens, or desiccation prevent and breaking dormancy when climatic conditions are favorable again (Godan, 1983). Three common land snails, *Eobania vermiculata* (Müller) , *Theba pisana* (Müller) (Gastropoda: Helicidae) and *Monaches obstructa* (Pfeiffer) (Gastropoda: Hygromiidae) are important crop pests and cause considerable damage in agriculture and horticulture, especially in areas where they find the conditions necessary for rapid multiplication. Land snails caused damage depends on their feeding habits which differ from one species to another. The land snails feed on leaves, roots, tubers and ornamental plants; in addition, an undesirable smell cause during movement snails which not only

prevent men and even animals from feeding on these contaminated plants but also on their population density and activity (El-Okda, 1981 and 1984). *M. cartusiana* caused damage about 5.65% (5.082 tons/feddan) to fresh plant of the Egyptian clover by consecutive cutting.

The work aims to survey the different terrestrial snail species that dominant in the citrus orchards at Qalubiya and Sharkia Governorates. Also, the vertical and horizontal distribution of common terrestrial snail abundance and knowledge of the seasonal activity for terrestrial snails and numerical density in different lands.

Materials and methods

1. Work area:

The present work was conducted in citrus orchard at Hod elfadel, Almohamdia, Minya Al-Qamh district, Sharkia Governorate that was heavy infested with different types of weeds and Shoubra Hars, Toukh district, Qalubiya Governorate.

2. Dispersal on orange trees:

2.1. Vertical:

Abundance density of terrestrial snail were measured during three successive growing seasons (winter, spring and summer) on orange trees during 2018/2019. Three levels for each tree were chosen as to follow 1, 2 and 3 meters for each. All live snail adults and juveniles were counted and recorded.

2.2. Horizontal:

White garden snail *T. pisana* and brown garden snail *E. vermiculata* abundance density snails were counted on soil surface at the different distances 1, 3 and 5 m from adjacent. All live snail adults and juveniles were recorded.

3. Statistical analysis:

All work data were statistically analyzed, using Costat Statistical Program Software (1990) and then Duncan's Multiple Range Test (Duncan, 1955) at 5% probability level to compare the differences among means.

Results and discussion

The herbivorous land snail's species, white garden snail, *T. pisana* and brown garden snail *E. vermiculata* were found on orange trees at Qalubiya and Sharkia Governorates. The identified species varied in incidence and level of infestation according to each locality. The snail, *E. vermiculata* was recorded in surveyed localities, but *T. pisana* snail was found and counted on certain orange trees at Sharkia Governorate only.

1. Vertical dispersal on orange trees:

1.1. Qalubiya Governorate:

Data in Table (1) and Figure (1) showed different abundance density of *E. vermiculata* snails on orange trees from level to level and from season to another. It is observed that the numerical density decreases with increasing distances on orange trees, where averaged in Table (1) 13.3, 6 and 2.1 snails for winter at 1, 2 and 3 meters, respectively, and averaged 28.5, 10.5 and 5.2 snails for spring and 22.8, 8.75 and 3.3 snails for summer, respectively. The same trend was observed regarding general means where averaged 21.53, 8.8 and 3.52 for the three levels, respectively.

1.2. Sharkia Governorate.

Table (2) and Figure (2) demonstrated that distance of 1, 2 and 3 meters had averages 15.2, 8.06 and 4.2 *E. vermiculata* snails for winter; 20.01, 13.3 and 7.02 for spring and 18.6, 9.04 and 4.8 *E. vermiculata* snails for summer, respectively. Also, the observed regarding general means had the same trend where averaged were 17.9, 10.13 and 5.34 for the three levels, respectively. As presented in Table (3) and Figure (3), the spring season harbored the highest abundance density for the three levels. The third level gave the lowest abundance density level snails, *T. pisana* for winter, spring and summer, respectively. Also, the data in the same table resulted that general mean regarding the first levels > the second levels >the third levels.

2. Horizontal distribution on soil surface (orange orchards) at different distances:

Horizontal distribution of *E. vermiculata* and *T. pisana* snails were counted on soil surface at the different distances 1, 3 and 5 m from adjacent orchards for the three growing seasons 2018/2019 at Shoubra Hars, Toukh districts, Qalubiya governorate and Hod elfadel, Almohamdia, Minya Al-Qamh districts, Sharkia governorate.

3. Horizontal distribution on orange orchards.

Results in Tables (4, 5 and 6) and Figures (4,5 and 6) showed abundance density was decreased by increasing distances from the adjacent tree orchards for the three growing seasons.

3.1. Qalubiya Governorate:

The results of Table (4) and Figure (4) indicated that *E. vermiculata* snail was recorded 9.3, 2, 1.1 and 18.06, 7.75, 2.3 and 17.1, 6.05 and 1.75 snails for winter, spring and summer, respectively. The same trend was observed for general mean where abundance density recorded 14.82, 5.27 and 1.72 for the three levels (1, 3 and 5 m, respectively).

3.2. Sharkia Governorate:

Table (5) and Figure (5) indicated that *E. vermiculata* recorded 7.8, 3 and 1.3 snails for winter; 11.9, 6.75 and 2.9 snails for spring and 6.09, 4.05 and 1.75 snails for summer. Also, data in Table (6) indicated that *T. pisana* snails was first levels > the second levels > the third levels. The same trend was observed for general mean where abundance density recorded in Table (5); 8.59, 4.6 and1.98 and recorded in Table (6), 11.93, 6.93 and 2.98 for the three levels (1, 3 and 5 m, respectively). So, it could be mentioned that abundance density on soil surface differences during the three-growing season (winter, spring and summer) and with different types of weeds. Many authors discussed the activity of snails during the growing season. In Egypt, numbers of active snails, *E. vermiculata* on soil were higher than those on trunk where numbers of counted on one-meter heights on the trunk of trees (Ismail *et al*., 2003). The distance moved by *M. cantiana* during two days in fallow lands and cultivated ranged between 0.5 and 6 m (Arafa, 2006 and Awad, 2014) that revealed the population fluctuations of land snails varied according to temperature, relative humidity and crop kind. The snails were more active during spring than autumn and lower in winter. Abdel Kader *et al.* (2016) reported the highest average of *T. Pisana* was recorded on fruit trees pear, fig, pomegranate and guava. Fig harbored the highest numbers followed by Pear while Pomegranate was the least once in this respect. Ismail *et al.* (2017) reported the population density of snails decreased by increasing distances on navel orange trees in vertical distribution. Also, it can be concluded that it is recommended to carry out pest control operations near the surface of the soil and near the tree trunks.

Table (1): *Eobania vermiculata* terrestrial snail abundance on orange trees at different levels during the growing season 2018/2019 at Qalubiya Governorate .

Levels	Abundance density at different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m	13.3^{c}	28.5^{a}	22.8^{b}	21.53^{b}	2.215	0.856	0.784	95.94	0.000 ***
2m	6^{b}	10.5^{a}	8.75^{a}	8.8^{a}	2.718	0.812	0.829	5.621	0.0354 *
3m	2.1^{c}	5.2^{a}	3.3^{b}	3.52^{b}	0.816	0.911	0.897	29.32	0.0006 ***

r= correlation R= regression P= probability *= significant

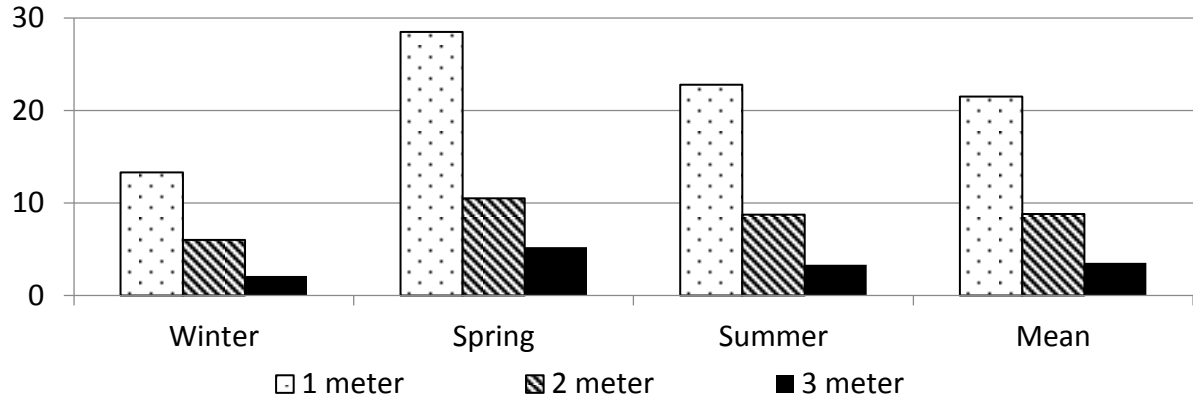

Figure (1): *Eobania vermiculata* terrestrial snail abundance on orange trees at different levels during the growing season 2018/2019 at Qalubiya Governorate.

Table (2): *Eobania vermiculata* terrestrial snail abundance on orange trees at different levels during the growing season 2018/2019 at Sharkia Governorate.

Levels	Abundance density at different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m	15.2^{c}	20.01^{a}	18.6^{ab}	17.9^{b}	1.798	0.838	0.747	15.09	0.003 **
2m	8.06^{c}	13.3^{a}	9.04^{bc}	10.13^{b}	1.631	0.963	0.947	23.28	0.001 **
3m	4.2^{c}	7.02^{a}	4.8^{bc}	5.34^{b}	0.999	0.809	0.6909	17.65	0.002 **

r= correlation R= regression P= probability *= significant

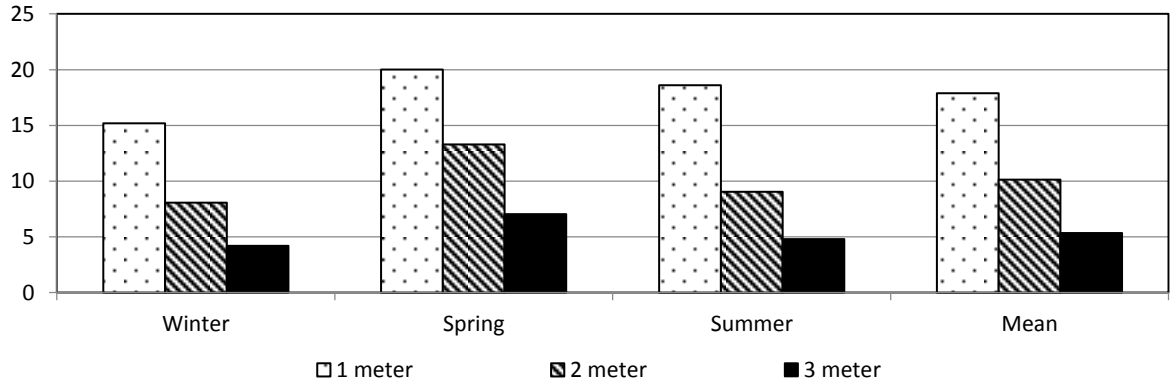

Figure (2): *Eobania vermiculata* terrestrial snail abundance on orange trees at different levels during the growing season 2018/2019 at Sharkia Governorate.

Table (3): *Theba pisana* terrestrial snail abundance on orange trees at different levels.

Levels	Abundance density at different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m	30.8^{c}	48.9^{a}	33.09^{c}	37.59^{b}	2.579	0.781	0.612	116.6	0.000 ***
2m	15.6^{bc}	18.75^{a}	13.05^{c}	15.8^{b}	1.579	0.947	0.919	9.783	0.010 **
3m	5.3^{b}	7.09^{a}	2.75^{c}	5.05^{b}	1.631	0.706	0.558	14.27	0.004 **

r= correlation R= regression P= probability *= significant

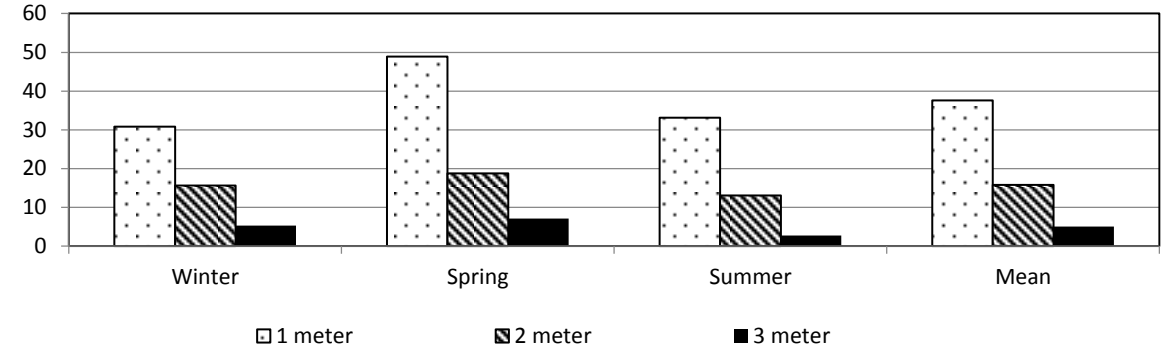

Figure (3): *Theba pisana* terrestrial snail Abundance on orange trees at different levels during the growing during the growing season 2018/2019 at Sharkia Governorate season 2018/2019 at Sharkia Governorate.

Table (4): *Eobania vermiculata* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Qalubiya Governorate.

Levels	Abundance density at different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m	9.3^{c}	18.06^{a}	$17.\ 1^{a}$	14.82^{b}	1.695	0.963	0.930	66.99	0.001
3m	2^{c}	7.75^{a}	6.05^{b}	5.27^{b}	0.999	0.801	0.794	69.81	0.000
5m	1.1^{b}	2.3^{a}	1.75^{ab}	1.72^{ab}	0.865	0.731	0.747	3.564	0.087

r= correlation R= regression P= probability *= significant

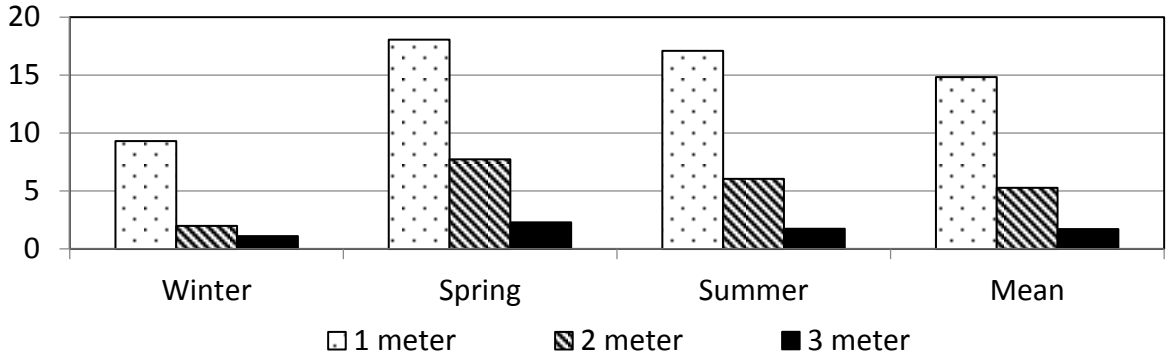

Figure (4): *Eobania vermiculata* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Qalubiya Governorate.

Table (5): *Eobania vermiculata* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Sharkia Governorate.

Levels	Abundance density at different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m A	7.8^{b}	11.9^{a}	6.09^{c}	8.59^{b}	0.999	0.857	0.804	71.32	0.000 ***
3m B	3^{c}	6.75^{a}	4.05^{b}	4.6^{b}	0.785	0.919	0.856	29.94	0.0005 ***
5m C	1.3^{b}	2.9^{a}	1.75^{b}	1.98^{ab}	0.658	0.754	0.593	5.447	0.0379 *

r= correlation R= regression P= probability *= significant

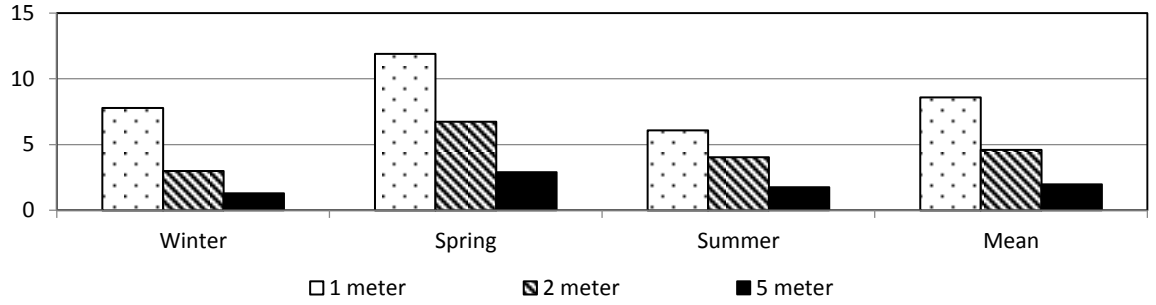

Figure (5): *Eobania vermiculata* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Sharkia Governorate.

Table (6): *Theba pisana* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Sharkia Governorate.

Levels	Abundance density in different seasons				L.S. $D_{0.05}$	r	R	F test	P
	Winter	Spring	Summer	Mean					
1m	10.8^{bc}	14.9^{a}	10.09^{c}	11.93^{b}	1.153	0.780	0.652	40.45	0.0002 ***
3m	5^{c}	8.75^{a}	7.05^{b}	6.93^{b}	0.998	0.903	0.897	21.15	0.0014 **
5m	2.3^{b}	3.9^{a}	2.75^{ab}	2.98^{ab}	1.025	0.832	0.699	4.085	0.0674 ns

r= correlation R= regression P= probability *= significant

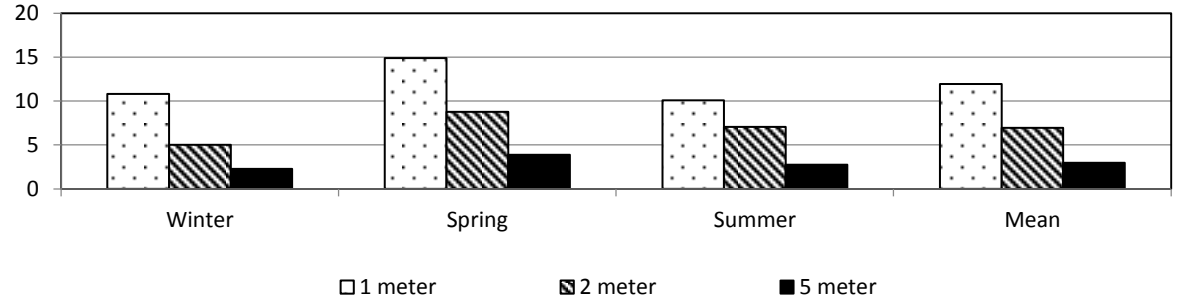

Figure (6): *Theba pisana* terrestrial snail abundance on orange orchards at different levels during the growing season 2018/2019 at Sharkia Governorate.

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