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RESEARCH ARTICLE

SURVEY AND POPULATION DYNAMIC OF TERRESTRIAL GASTROPODS INFESTING CERTAIN CROPS AT SHARKIA GOVERNORATE, EGYPT.

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Abstract

This study was carried out on certain places at Sharkia Governorate, Egypt to survey the most common terrestrial gastropods infesting vegetable and field crops. Results revealed that most crops highly infested with *Monacha cartusiana* snails, while *Succinea putris* and *Deroceras laeve* had moderately to low infestation. As in the case of *Monacha cantiana*, it was recorded for the first time on Sharkia Governorate. Regarding population dynamics Egyptian clover harbored the highest numbers of snails, followed by wheat and sugar beet during February, March and April. Inconstant relationship were found between population dynamics and both temperature and relative humidity.

Introduction:-

Molluscs are the second huge phylum of the animal kingdom, forming a major part of the world fauna **(Lush, 2007).** So, they are considered one of the most successful phyla among the animal kingdom. Gastropods are the most successful molluscs which have invaded land **(Smith and Kershaw, 1979).** The 20th century witnessed the emergence of gastropods as important crop pests in temperate and tropical regions, the increased pest status has been associated with cultivation of new crops, intensification of agricultural production systems, and the spread through human trade and travel of species adapted to these modified environments **(Barker, 2002).** Among gastropods, are land snails belonging to subclass, Pulmonata which is one of the most numerous with almost 35,000 described species of the world **(Solem, 1984).** In Egypt, land molluscs are introduced as new pests in agricultural crops, it caused great damage to vegetable and field crops, orchards and other plants **(Kassab and Daoud, 1964 and Asran, 1994).** This study aimed to surveying the most important endemic gastropods and population dynamic for the most common species infesting certain field crops at Sharkia Governorate, Egypt.

Materials And Methods:-

Survey of terrestrial gastropods infesting different crops at Sharkia Governorate:-

A survey study was carried out at three districts (Hehia, El-Ibrahimia and Deiarb Negm) in Sharkia Governorate, Egypt during the period from October 2013 till September 2015. At each district, three villages were randomly chosen. These localities were Hehia: (Hehia El-Balad, Mahdia and Manzel-Hayan), El-Ibrahimia: (El-Hebsh, Kafr El-Shorafa and Mubasher) and Deiarb-Negm: (Ekrash, El-Hawaber and El-Mugafaf). Survey was undertaken on many host plant species including filed crops as Egyptian clover, (*Trifolium alexandrinum*); maize, (*Zae mays*); wheat, (*Triticum aestivum*); broad bean, (*Vicia faba*): sugar beet, (*Beta vulgaris*); barley, (*Hordeum vulgare*) and kidney bean, (*Phaseolus vulgaris*) and vegetable crops i.e. cabbage, (*Brassica oleracea*); onion, (*Allium cepa*);

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lettuce, (*Lactuca sativa*); egg plant, (*Solanum melongena*); tomato, (*Solanum lycopersicum*); cucumber, (*Cucumis sativus*); garlic, (*Allium sativum*); okra, (*Abelmoschus esculentus*); dill, (*Anethum graveolens*) and parsley, (*Petroselinum crispum*). Samples were taken from each field crop by using the quadrate sample size 50x50cm (**Staikou et al., 1990).** Snails from each host plant in the different host plant were collected and transfer in plastic box to laboratory for identification using key given by (**Godan, 1983).**

Population dynamics of *Monacha cartusiana* on certain field crops:-

The seasonal population dynamics of *M. cartusiana* infesting certain field crops were studied at Mubasher village El-Ibrahimia district during two successive growing seasons (2014/2015 and 2015/2016). Three field crops Egyptian clover, wheat and sugar beet were chosen for this study. An area of about one feddan was selected for each crop. Five replicates of quadrate sample size (50x50cm) were examined biweekly intervals during the growing season of each crop (**Staikou et al., 1988).** Examination was undertaken during early morning in absence of sunshine. All snails found on plants or on soil surface in the quadrate were counted and left in their initial places **(Baker, 1988).** Data concerning temperature and relative humidity during the period of study were obtained from the Metrological Station of Zagazig. Obtained data were subjected to statistical analysis as correlation coefficient between snails population and each of temperature and relative humidity according to **(Costat, 2005).**

Results:-

Survey studies of terrestrial gastropods in certain districts at Sharkia Governorate:-

An extensive survey was carried out on terrestrial molluscs infesting different crops at 9 villages belonging to three districts at Sharkia Governorate. Results present in **Table (1)** revealed that three species of herbivorous land snails were found on different host plants. Moreover terrestrial slug belonging to different families of order: stylommatophora. These families were: Hygromiidae (*Monacha cartusiana* and *Monacha cantiana*), Succineidae (*Succinea putris*) and family: Agriolimacidae (*Deroceras laeve*) **Fig., (1)**. The identified species varied in their incidence and level of infestation according to the locality and the host type. It obvious that *M. cartusiana* snail has the upper hand on terrestrial molluscs incidence compared with the other species since it was recorded in all surveyed localities. Moreover, the majority of the examined plants were liable to be infested by this snail followed by *S. putris, M. cantiana* while *D. laeve* was the lowest one observed on the host plant. Generally, the listed hosts can be classified into three categories according to the degree of infestation. These categories were heavy, moderate and light infestation. The majority of examined crops were found with heavy infestation with *M. cartusiana* especially Egyptian clover, wheat, lettuce, cabbage. Broad bean, egg plant, onion, cucumber and kidney bean were detected with moderate infestation. On the other hand, barley, maize, garlic, okra, sugar beet, dill, tomato and parsley were detected with light infestation. In respect to *S. putris, M. cantiana* and *D. laeve* they recorded for the first time on Egyptian clover and wheat at Mubasher village (El-Ibrahimia district) with moderate to light infestation.

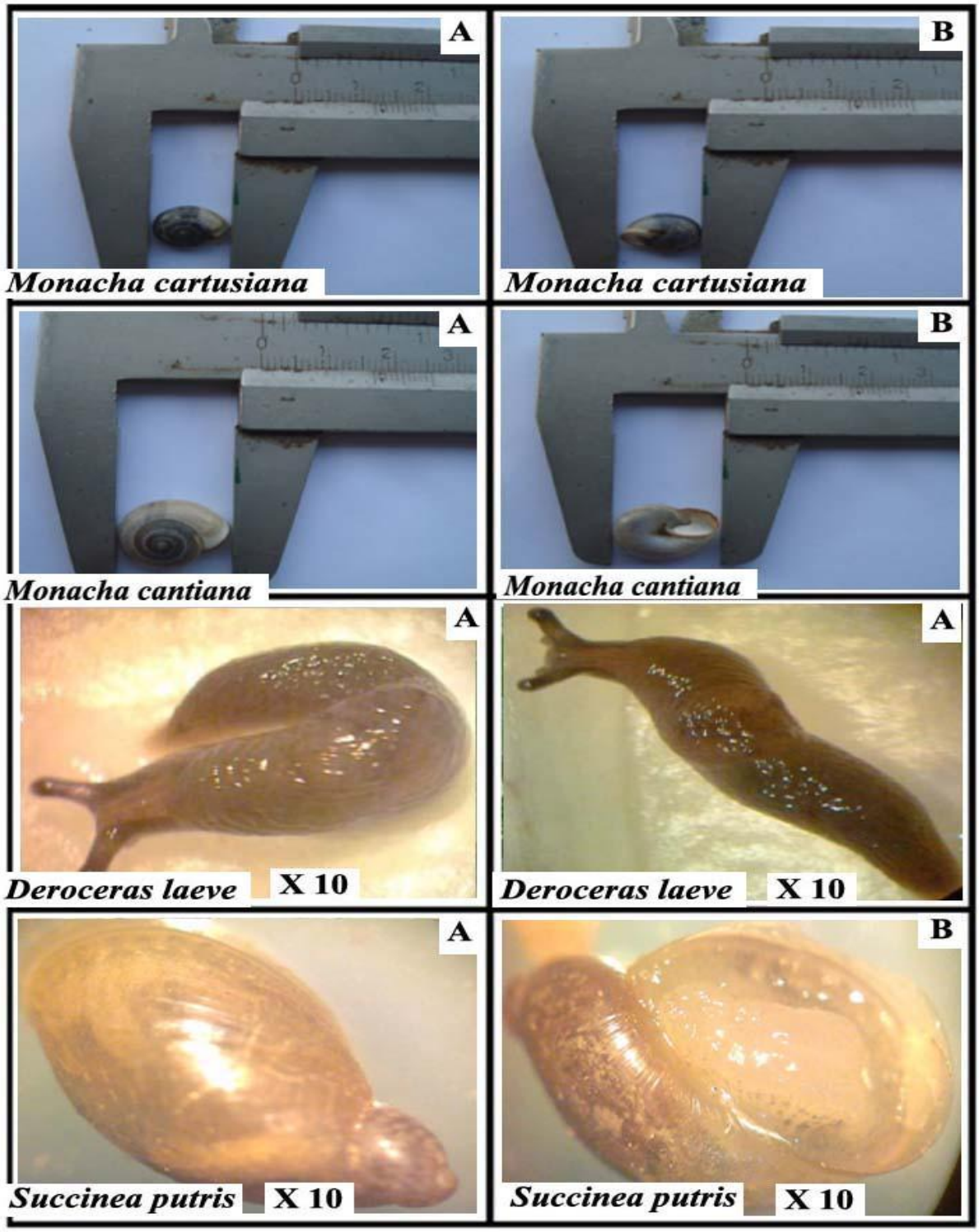

Fig 1:- Terrestrial gastropod occurred on Sharkia Governorate. Note (A) dorsal view, (B) ventral view.

Table 1:- Survey of terrestrial gastropods and level of infestation on different corps at certain districts at Sharkia Governorate.

District	Localities	Gastropod species	Host plant
Hehia	Hehia El-Balad	*M. cartusiana*	Egyptian clover(+++), Wheat(+++), Broad bean(++), Barley(+), Maize(+), Cabbage(+++), Lettuce(+++), Egg plant(++), Onion(++), Cucumber(++), Garlic(+), Okra(+), Tomato(+)
		S. putris	Egyptian clover (+)
	Mahdia	*M. cartusiana*	Egyptian clover (+++), Wheat(++), Lettuce(+++), Egg plant(+), Onion(+), Cabbage(+++), Dill(+), Parsley(+)
	Manzel-Hayan	*M. cartusiana*	Egyptian clover (+++), Wheat(++), Onion(+), Cabbage(+++), Dill(+), Parsley(+)
El-Ibrahimia	El-Hebsh	*M. cartusiana*	Egyptian clover (++), Wheat(+), Onion(+), Cabbage(+++)
	Kafr El-Shurafa	*M. cartusiana*	Egyptian clover (+++), Wheat(+++), Cabbage(+++), Lettuce(+++)
	Mubasher	*M. cartusiana*	Egyptian clover (+++), Wheat(+++), Broad bean(+), Onion(+), Garlic(+), Lettuce(+), Sugar beet(+), Kidney bean (++)
		S. putris	Egyptian clover (++), Wheat(+)
		D. laeve	Wheat(+)
		M. cantiana	Egyptian clover (++), Wheat(+)
Deiarb-Negm	Ekrash	*M. cartusiana*	Egyptian clover (+++), Wheat(++), Egg plant(+)
	El-Hawaber	*M. cartusiana*	Egyptian clover (+++), Wheat(+++), Onion(+)
	El-Mugafaf	*M. cartusiana*	Egyptian clover (++), Wheat(+), Lettuce(+), Okra(+)

(+)= low infestation (less than 15 snails/0.25m^2).
(++)= Moderate infestation (between 16-30 snails/0.25m^2).
(+++)= heavy infestation (more than 30 snail/0.25m^2).

Seasonal population dynamics of *M. cartusiana* on certain field crops at Sharkia Governorate:-

Survey studies showed that the glassy clover snail *M. cartusiana* was the predominant species with a relatively high numbers on major economic crops. Therefore, population dynamics of such snail was studied on Egyptian clover, wheat and sugar beet in Mubasher village, El-Ibrahimia district, Sharkia Governorate during the two successive growing seasons 2014/2015 and 2015/2016. Data in **Table (2)** and **Fig., (3&4&5)** showed that the initial infestation of *M. cartusiana* was appeared in the beginning of November on Egyptian clover with a relatively low population densities of (2.8 & 2.2) snails per quadrate size of 50x50 cm in the growing season 2014/2015 and 2015/2016, respectively While on sugar beet the initial infestation was appeared in the beginning of December with a relatively low population densities of (0.6 & 0.4) snails per quadrate sample size of 50x50 cm in the growing season 2014/2015 and 2015/2016, respectively. In respect to Wheat the initial infestation was appeared in the mid of February with a relatively low population densities of (8.6 & 13.4) snails per quadrate sample size of 50x50 cm in the growing season 2014/2015 and 2015/2016, respectively. Regarding the behavior of *M. cartusiana* population after the initial infestation, it is cleared that the number of snails were slightly increased to reach its peck (89.6, 58.4& 30.2, 29.4) at the mid of March for two successive growing season 2014/2015 and 2015/2016 for Egyptian clover and wheat, respectively. The number of snail per quadrate sample size of 50x50 cm at the end of growing season 2014/2015 and 2015/2016 for Egyptian clover, wheat and sugar beet were (19& 10.4), (21.4& 18.6) and (11.6& 9.8), respectively.

In general, it noticed that, Egyptian clover harbored the highest number of snail per quadrate sample size 50x50 in which general mean record (25.64 & 23.49) for two successive season 2014/2015 and 2015/2016 followed by wheat (7.94 & 7.88) while sugar beet is the lowest one which gave (3.28 & 2.78).

Table 2:- Population dynamic of *M. carusiana* in Mubasher village, El-Ibrahimia district, Sharkia Governorate during the two growing seasons 2014/2015 and 2015/2016.

Date of inspection	Avarege number of snail sample/ 0.25m^2						Temperature (ºC)		R.H. %	
	Egyptian clover		Wheat		Sugar beet					
	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
1 Sep.	-	-	-	-	0	0	30	27.75	52.63	48.59
16 Sep.	-	-	-	-	0	0	28.8	29.8	48.3	54.73
1 Oct.	-	-	-	-	0	0	28.03	30.76	47.33	41.57
16 Oct.	0	0	-	-	0	0	24.4	26.47	51.2	53.33
1 Nov.	2.8	2.2	-	-	0	0	23.59	23	48.59	51.38
16 Nov.	1	0.4	0	0	0	0	21.36	20.97	50.73	64.7
1 Dec.	3.2	0.8	0	0	0.6	0.4	18.16	20.9	60.26	53.5
16 Dec.	5.6	1.2	0	0	2.6	2.4	18.6	15.97	53.47	58.77
1 Jun.	4.8	7	0	0	5	4.8	15.78	14.31	53.88	54.86
16 Jun.	10.4	9	0	0	7.2	5.2	11.83	15.2	48.93	49.3
1 Feb.	17	16.6	0	0	12.4	10.8	15.68	11.13	46.88	53
16 Feb.	32.2	42.4	8.6	13.4	11.6	9.8	15.17	16.2	41.6	52.73
1 Mar.	34.6	55.2	19.2	17.4	-	-	14.19	24.71	55.92	50
16 Mar.	89.6	58.4	30.2	29.4	-	-	18.1	21.57	56.07	45.3
1 Apr.	60.4	44.8	21.4	18.6	-	-	18.84	19.16	49.44	43.41
16 Apr.	52.2	56.8	-	-	-	-	19.37	25.3	48.7	42.73
1 May	51.8	47.2	-	-	-	-	22.47	25.53	38.53	40.17
16 May	19	10.4	-	-	-	-	27.47	27.87	51.3	43.1
Total	384.6	352.4	79.4	78.8	39.4	33.4				
General mean	25.64	23.49	7.94	7.88	3.28	2.78				

The correlations between some climatic factor i.e. temperature or relative humidity and population density of *M. cartusiana* during the two successive growing seasons were subjected to statistical analysis. Data presented in **Table (3)** and **Fig., (2)** revealed that temperature and relative humidity showed a variable effect on population density of *M. cartusiana*. Since correlation coefficient values differed from one host to another in the two seasons of the experiment. For instance on wheat and Egyptian clover temperature showed insignificant positive effect on number of *M. cartusiana* during growing seasons 2015/2016. On the other hand insignificant negative correlation was found on Egyptian clover during 2014/2015 and on sugar beet during 2015/2016. In contrast highly significant negative effect was observed on sugar beet during season 2014/2015. Concerning the effect of relative humidity on population density of *M. cartusiana*, it was noticed that the obtained results were not constant for sample. Insignificant negative correlation was observed on Egyptian clover during growing season 2014/2015 and growing season 2015/2016 for sugar beet. While highly significant negative correlation was noticed on Egyptian clover during growing season 2015/2016 and during 2014/2015 for sugar beet. In respect to wheat insignificant positive correlation was noticed during growing season 2014/2015 and significant negative correlation was observed during growing season 2015/2016. Generally, there is no definite correlation between temperature or relative humidity and population dynamic of *M. cartusiana* during the two successive seasons.

Table 3:- Correlation between temperature, relative humidity and population density of *Monacha cartusiana* on different crops at Sharkia Governorate**.**

Host plant	Temperature ºC		Relative humidity %	
	2014/2015	2015/2016	2014/2015	2015/2016
Egyptian clover	-0.097 ns	0.222 ns	-0.158 ns	-0.653**
Wheat	0.074 ns	0.540 ns	0.138 ns	-0.699 *
Sugar beet	-0.746 **	-0.792 ns	-0.511 **	-0.001ns

ns = not significant *= significant **= highly significant

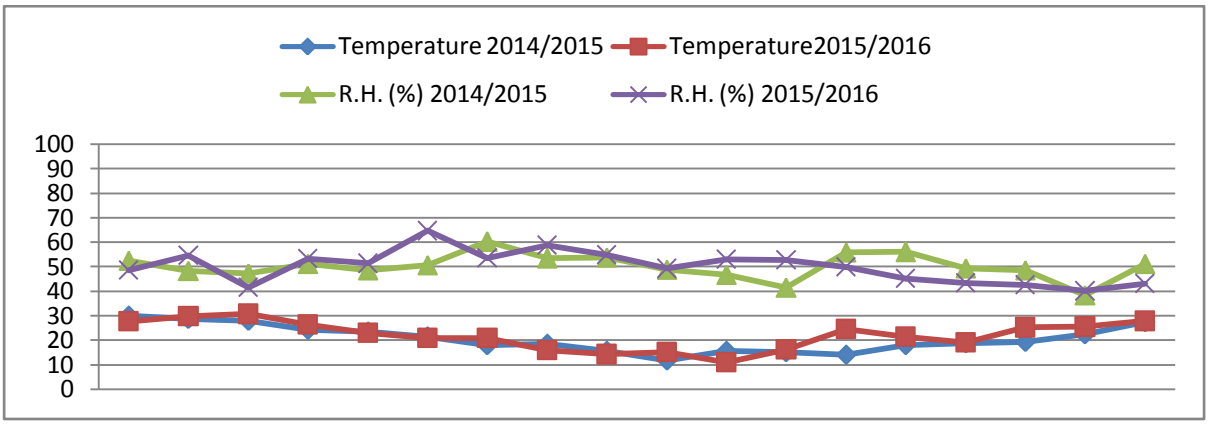

Fig 2:- Temperature and relative humidity during two successive seasons 2014/2015 and 2015/2016.

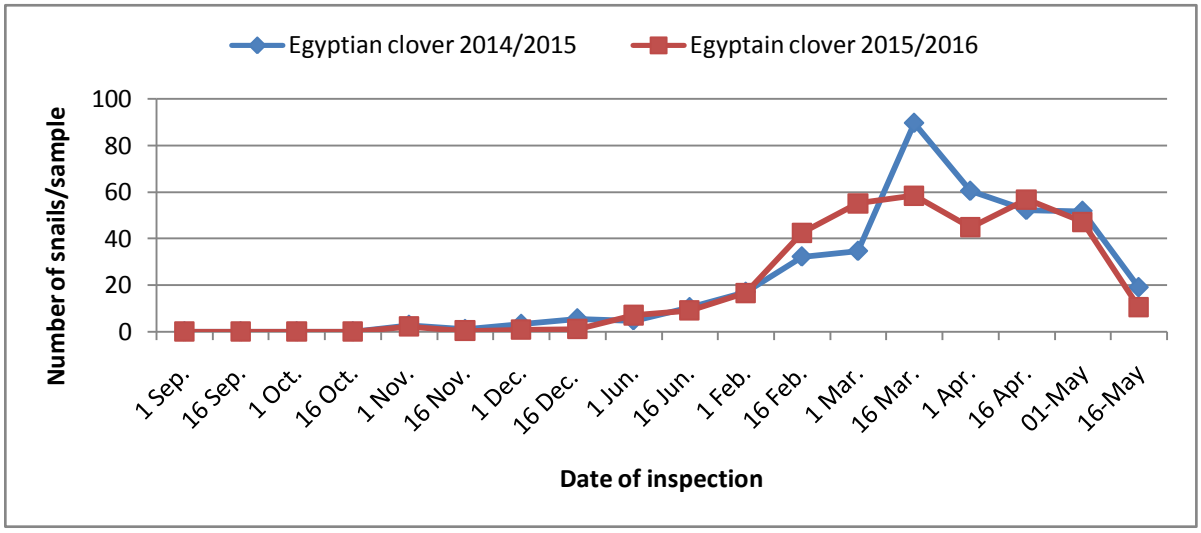

Fig 3:- Population dynamics of *M. cartusiana* snail infesting Egyptian clover in Mubasher village during two successive season 2014/2015 and 2015/2016.

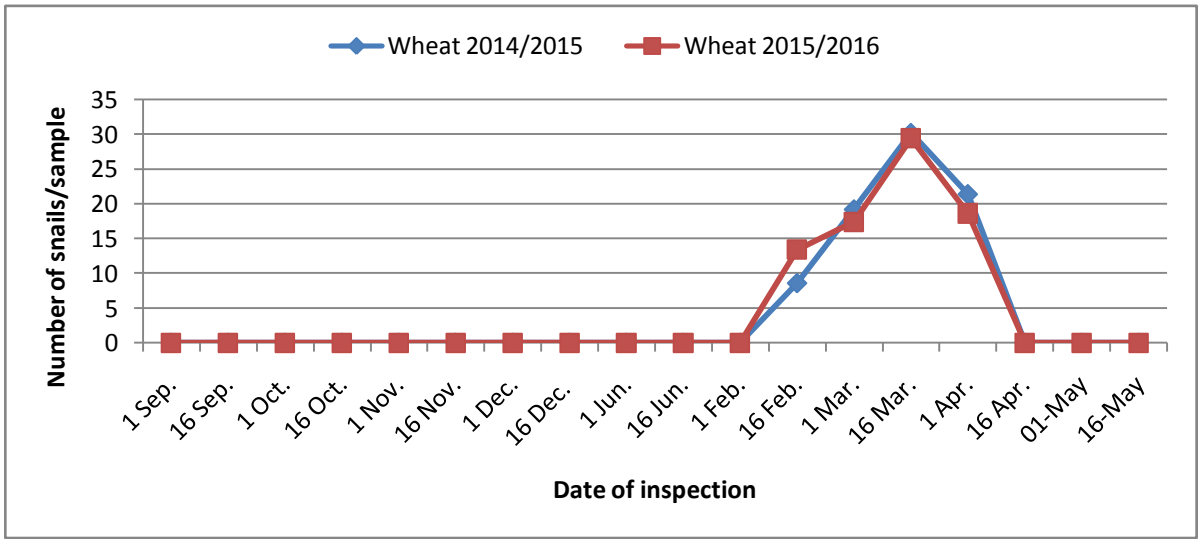

Fig 4:- Population dynamics of *M. cartusiana* snail infesting wheat in Mubasher village during two successive season 2014/2015 and 2015/2016.

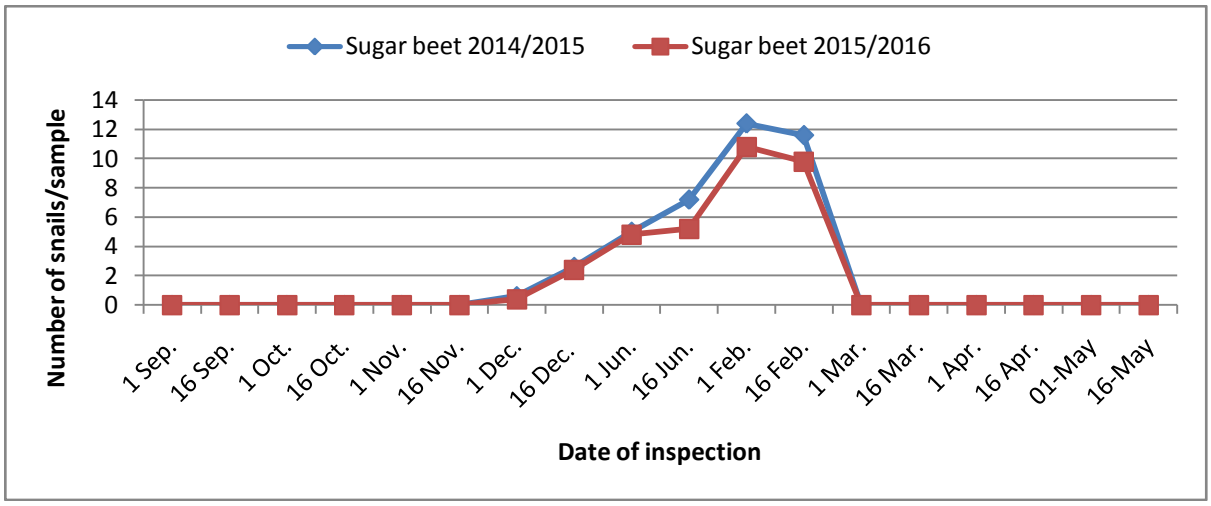

Fig 5:- Population dynamics of *M. cartusiana* snail infesting sugar beet in Mubasher village during two successive season 2014/2015 and 2015/2016.

Discussion:-

Results of the present study revealed that the land snail *M. cartusiana* snail occupy the first on incidences and level of infestation followed by *S. putris* while *D. laeve* was found on some locality at Sharkia Govenorate. While, *M. cantiana* recorded for the first time at Sharkia Governorate. Discussing the foregoing results, it is well know that land snails and slugs were recorded as serious pests to agricultural crops in different places in Egypt. The terrestrial snails were found at different Governorates attacking many economic crops. For instances: at Sharkia Governorate, **Arafa, (1997)** found that, *M. cartusiana* infested hosts with few, moderate and high numbers in Meniet El-Kamh district. **Mahrous *et al.*, (2002)** detected five species of land snails in different localities of Sharkia Governorate. There were 12 districts containing 44 localities infested with land snails, *M. cartusiana*, *Helicella vestalis, Cochlicella acuta, Eobania vermiculata* and *Succinea* sp. **Shetaia, (2005)** surveyed the terrestrial molluscs infesting different crops at 14 localities representing 7 districts of Sharkia Governorate. Five herbivorous land snail species were found on different host plants. These species were *M. cartusiana, H. vestalis, E. vermiculata, C. acuta* and *S. putris*. **Ghareb, (2007)** cleared that, the land snail *M. cartusiana* was the only snail which found in all in 12 villages at Meniet El-Khamh district, Sharkia Governorate, while, *S. putris* land snail was appeared only one time as individual snail in El-Godaida village. **Lokma, (2007)** revealed that the glassy clover snail, *M. cartusiana* infested the examined crops in all inspected localities of Sharkia Governorate, except wheat and broad been in Serag EL-Deen (Belbies district) and wheat as well as broad bean in Kafr-Sakr El-Balad and Teliga (Kafr-Sakr district), respectively , while the conical snail *C. acuta* was found in El-Katiba village (Belbies district). The slugs *Deroceras reticulatum* and *D. laeve* were recorded for the first time on Egyptian clover in Meniet El-Kamh and Zagazig districts. **Shetaia *et al.*, (2009)** reported that the glassy clover snail *M. cartusiana* and the amber snail, *S. putris* were found at Awlad-Sakr and Abo-Kapeer district, Sharkia Governorate. *M. cartusiana* snail was found with higher density than *S. putris*. The majority of examined crops were found with heavy infestation with *M. cartusiana* snail while *S. putris* were recorded with moderate or light infestation in the examined localities. **Ismail *et al.*, (2011)** revealed that, *M. cartusiana* and *S. putris* snails were found at Hehia and Meniet El- Kamh while *M. cartusiana* was found with higher density than *S. putris* on agricultural crops and weeds. The majority of the examined crops were found with heavy infestation with *M. cartusiana* while infestation with *S. putris* was found light of moderate. **Rady *et al.*, (2014)** revealed that five species were found infesting different crops in Ismailia and Sharkia Governorates. These species were *M. cartusiana, C. acuta, S. putris, D. laeve* and *D. reticulatum*. The last species was recorded for the first time in Ismailia Governorate.

Regarding, seasonal population dynamics of *M. cartusiana* snail on certain field crops at Sharkia Governorate. The present study revealed that Egyptian clover harbored the highest numbers of *M. cartusiana* followed by wheat while sugar beet showed the lowest number. Population density values of *M. cartusiana* on the tested crops were higher than in the first growing season 2014/ 2015 compared to those counted in the later growing season of 2015/2016. In Egyptian clover and wheat crops the population density of *M. cartusiana* obviously increased during (February,

March and April) months as compared to the other months. In respect to sugar beet the population density was high in January and February months compared with the other months.

Obtained results of population dynamics on different crops at Mubasher village were very similar to results reported by many authors. **Ismail, (1997)** revealed that the population density of *M. cartusiana* on field and vegetable crops was obviously increased during spring months as compared to the population density during winter and autumn months in certain localities of Sharkia Governorate, while the infestation did not appear during summer months. Moreover, Egyptian clover harbored the highest numbers of *M. cartusiana* followed by cabbage and wheat. On the other hand, there is no definite correlation between temperature or relative humidity and population density of *M. cartusiana* on the tested crops during the two successive growing seasons of the study. **Hegab *et al.*, (1999)** found that Egyptian clover harbored the highest numbers of *M. cartusiana* followed by wheat, while broad bean showed the lowest numbers. **Mahrous *et al.*, (2002)** reported 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. **Lokma, (2007)** found that population density of this snail was obviously increased during spring months as compared to low or moderate values during autumn and winter months. Egyptian clover harbored the highest numbers followed by wheat. **Ismail *et al.*, (2011)** showed that population dynamics of *M. cartusiana* at Abo-Kapeer district, Sharkia Governorate was recorded with high density during spring months (March, April and May) as compared with winter or fall months. **Awad, (2013)** revealed that, the population density of these land snails were observed on the soil, stems and leaves of tested crops. The population density of all observed land snails was heavier on Egyptian clover followed by wheat and sugar beet, also recoded highest numbers through spring season followed by autumn and winter.

These results disagree with **Shetaia, (2005)** who found that at Kafr-Sakr district, Sharkia Governorate the highest population densities of *M. carusiana* on wheat was recorded during April. On the other hand, Egyptian clover gained the highest values of population density in May, during the two successive growing seasons of 1999/2000 and 2000/2001.

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