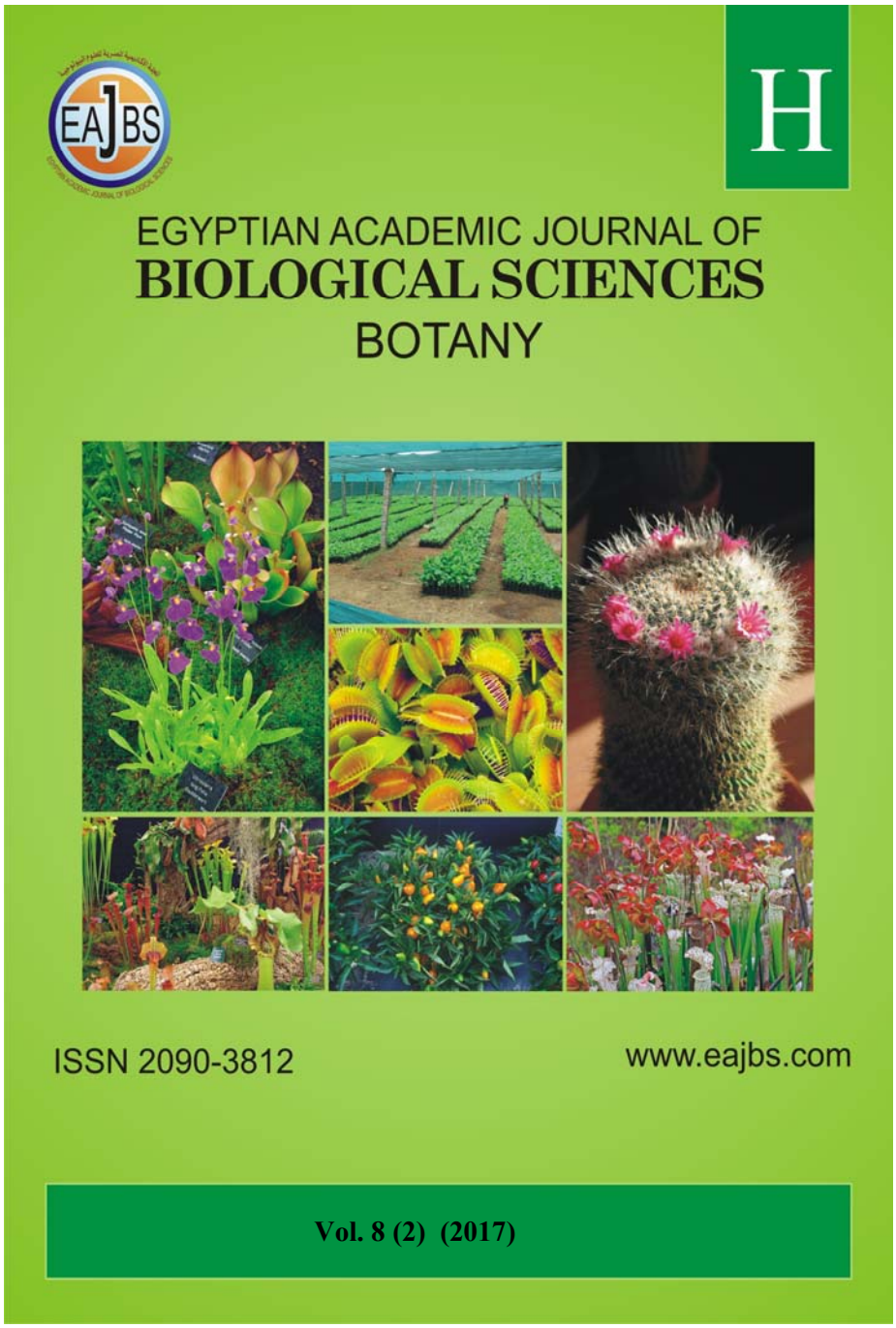


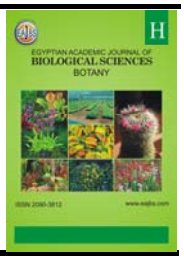
Egyptian Academic Journal of Biological Sciences is the official English language journal of the Egyptian Society for Biological Sciences , Department of Entomology ,Faculty of Sciences Ain Shams University .

The Botany Journal publishes original research papers and reviews from any botanical discipline or from directly allied fields in ecology, behavioral biology, physiology, biochemistry, development, genetics, systematic, morphology, evolution, control of herbs, arachnids, and general botany..

www.eajbs.eg.net

Egypt. Acad. J. Biolog. Sci.,8(2):11–20 (2017)

Egyptian Academic Journal of Biological Sciences
H. Botany
ISSN 2090-3812
www.eajbs.eg.net



Economic Threshold, Injury Levels and Food Preference of Glassy Clover Snail, *Monacha cartusiana* (Muller) Infesting Strawberry Plants at Ismailia Governorate, Egypt.

Ibrahim, M. M. A.; M. H. E. Lokma and M. A. Issa
Plant Protection Research Institute: Agricultural Research Center Dokki, Giza, Egypt

ARTICLE INFO
Article History
Received: 21/10/2017
Accepted: 11/11/2017

***Keywords*:**
glassy clover snail, strawberry plant pests, Economic threshold, injury levels, food preference

ABSTRACT

This study was carried out at Al Mahssama village, El Qassaseen district, and Ismailia Governorate during 2015 strawberry growing season. The paper aimed to assessment the economic damage threshold, economic injury levels and food preference of glassy clover snail, *Monacha cartusiana* (Muller) infested strawberry plants , *Fragaria ananassa* (Duchesne); festival cultivar using natural infestation (marking plants) and poison baits techniques. Also, two laboratory experiments were conducted to study food preference and consumption of *M. cartusiana* fed on three strawberry cultivars (Festival, Camarosa and Proprietary).

The obtained results cleared that the values of economic damage threshold ETLs were less than economic injury levels EJLs, where the control measurements must be under taken. Therefore, the economic threshold is essential to determine the proper application time of control trial which would covalent in successful integrated pest management. The economic damage threshold of M. cartusiana on strawberry plants ranged 2-2.5 snail/plant, while the economic injury level ranged 3-7.5 snail/ plant.

In addition, the results of laboratory experiments cleared that the food preference of M. cartusiana was varied as plant part and cultivar, where *M. cartusiana* snail preferred red fruits of Festival (39.02 mg/snail/day), green fruit of Proprietary (28.35 mg/snail/day) and fresh leaves of Camarosa (19.99 mg/snail/day) more than other tested food.

INTRODUCTION

Recently the land snails become one of key pests infesting field, vegetable, fruit and ornamental crops in Egypt, especially in northern Governorates of Delta region. The land snails were follow inspected attacking various crops causing which have great direct damage to all plant parts by chisels the epidermis and chewing soft of vegetative growth, flower, roots and tubers or indirect damage by left viscous liquids upon the plants, causing humans and farm animals refuse eating these plants

(El-Okda, 1980). Therefore, the total yield, benefits of yield and quality of infested plants are decrease economically. The snail species, *Monacha cartusiana* (Muller) was reported as a dominant species in different districts of Ismailia Governorate (Ghamry, *et al*., 1994; Nakhla, *et al*., 1995; Arafa, 1997; Ismail, 1997; El-Massry, 1997 and Lokma, 2013)

The use of economic thresholds as a basis for pests control decision making is a fundamental component in integrated pest management (Stern, et al., 1959). Proposed the concepts of an economic injury level (EIL) and economic threshold level (ETL) as rational comparison of the economic costs and benefits of pesticides use, EILs detected as the lowest number of pest cause economic damage, where the economic damage is the amount of damage that equal the control cost (Stern *et al*., 1959 and Pedigo *et al*., 1986). In fact, the EIL concept is that not all damage is economically significant, also many instances a certain levels of pest injury may be tolerated. It is also useful to determine a distinction between injury and damage. Injury can be distinct as the effect of pest activities against host physiology or morphology, damage as the measurable loss of host utility, which is usually measured by reduction in the commodity yield or quality (Bardner and Fletcher 1974 and Pedigo *et al*., 1986). Many authors have contributed to the understanding of host-land snail relationship, and much effort has been done towards developing damage assessment models and computing (Kassab and Daoud, 1964; El-Okda, 1984; Chang, 1991; El Massry, 1997, Ismail, 1997 and Ibrahim, *et al*., 2008). The effective infestation of land snails were varied as starting time from location to another and from crop to another (Mohamed-Ghada, 2004 and Lokma, 2013)

This study aimed to assessment economic threshold, injury levels and food preference for land snail, *M. cartusiana* infesting strawberry as bases for decision making recommendation for the pest control programs in field. Also, laboratory experiment was conducted to study the food preference of M. cartusiana fed on three strawberry cultivars.

MATERIALS AND METHODS

Assessment of economic damage threshold and economic injury levels:

Two field experiments were carried out in strawberry field at Al-Mahssama village, Al Qassaseen district, Ismailia Governorate during 2015 season to assessment of damage threshold and economic injury levels for the more existed land snail species; glassy clover snail, *Monacha cartusiana* (Muller) infesting strawberry plants, *Fragaria ananassa* (Duchesne); Festival cultivar, as natural infestation technique (Marking Plants) and using poison baits technique.

Using poison baits technique:

The area of 350 m2 cultivated with strawberry plants (Festival cultivar) was divided into sex plots where present belt inter between plots. The prepared poison bait of 16.5 kg (20:30:950 g of methomyl pesticide (Lannate): black honey: bran / kg bait, respectively). The black honey and bran were mixed in the morning , wetted , left till the day end (before sunset) and the methomyl pesticide (Lannate) was added, good mixed then the bait transferred to field and distributed in small stacks (approximately 100g based on dry weight) on blue (snail favorite color) plastic pieces (20*20 cm). The baits were distributed as: Four baits / m2 in the 1st plot (complete protected plot) , two baits / m2 in the 2nd plot, one bait / m2 in the 3rd plot, one bait / 2 m2 in the 4th plot, one bait / 4m2 in the 5th plot, while the last plot left without baits (check) the numbers of snails in the sex plots were counted weekly in the field during the

period extended from mid-February to end May in sample include randomized 10 meters of each plot. The yield of each plot was estimated at each harvest time and calculated as kg/meter.

Natural infestation technique (Marking plants experiment) :

Sample of 50 plants were chosen randomly from 1/4 fad (1050 m2) cultivated with strawberry plants (Festival cultivar), from the beginning date of snails infestation and labeled, then left to natural infestation. A snail numbers/labeled plant were count weekly at field till harvest on plant parts or on ground under plants. The strawberry ripe fruits (red fruits) yield of each plant were collected, counted and weighed in gram per individually from genesis starting maturity fruits as healthy, small and not marketable fruits (end season economically).

Statistical analysis for economic threshold and economic injury levels:

Data were subjected to a certain scheme of statistical analysis, according to Hosny *et al*., (1972), Salem and Zaki (1985) and Ibrahim (1994 & 2001); to calculate economic threshold and economic injury levels as follows:

Poison baits technique:

The correlation (r) and regression (b) values were used to show the variability in the yield refluxes to infestation during the whole season. Standard error "SE", "t" values, simple correlation and simple regression "b" were calculated. The slope (b) of straight regression line was carried out to obtain the corrected values for the yield. The chi-square analysis "rx2" was applied, the point at which the strawberry at the upper part of the slope start to show a significant drop could be taken as a threshold level.

Marking plants technique,

The partial regression formula" c-multipliers" – which has two independent variables (x1 and x2) were used , where the average number of snail per plant in the two peaks of population activity where (x1 and x2) , the dependent variable (y) represented the yield per plant . The partial regression was used to show the variability in the yield that could be caused by infestation during the whole season. Standard error "SE", "t" values, simple correlation and simple regression "b" were calculated. The slope (b) of straight regression line was carried out to obtain the corrected values for the yield. The linear regression curve obtained by transforming the (y) into logarithmic value using the following equation:

$$y = e^{-(a+bx)} \text{ (i.e., log. } Y = \pm bx)$$

The chi-square analysis "rx2" was applied, the point at which the strawberry at the upper part of the slope start to show a significant drop could be taken as a threshold level.

Food consumption and preference of *M. cartusiana* to strawberry cultivars under laboratory conditions:

Snails of *Monacha cartusiana* (Muller) shell diameter of 12-13 mm were collected from infested field cultivated with strawberry at Al-Mahssama village, Al Qassaseen district, Ismailia Governorate during April 2015. The collected Snails were left under laboratory condition of 25 ± 1 °C and 65 ± 5 % RH. for two weeks to adapting and starved for 24 hours before testing. Two experiments were conducted in laboratory of plant protection institute Sharkia branch: the first aimed to test plant part preference, calculated as daily plant part consumption in mg/snail/day (fresh leaves, complete red fruit and green fruit) of each cultivar (Festival, Camarosa and Proprietary) by introduce the three plant parts of each cultivar together and comparison. The second aimed to test host preference, calculated as daily consumption in mg/snail/day of strawberry cultivars by introduce each plant part

(leaves red fruits and green fruit) of the three cultivars together and comparison. Three replicated of 10 cm diameter plastic pots, each contain fifteen snails for each treatment, two of fresh leaves, red and green fruits were weighed before and after testing every 24 hours. The pots were kept clean by removing remain food when new food introducing. Food consumption and host preference was measured daily at a period three days successive, The obtained data were statistically analyzed using F-test as little and Hills, (1975).

RESULTS AND DISCUSSION

Assessment of economic threshold and economic injury levels:
Using poison baits technique:

The different levels of infestation in various poison baits treatments along with the corresponding average weight of strawberry yield in every treatment and their statistical analysis were given in Table (1) and illustrated in Fig. (1). The obtained results revealed that, the increasing infestation from 6.25 to 18.75 individual/m2 caused significant chi square (x^2 **). Strawberry yield was recorded 11.5 kg/m^2 with snail number of 6.25 individual/m^2, this decreased yield to 8.5 kg/m^2 with increasing snail number to 18.75 individual/m^2, so that 6.25 individual/m^2 considered as economic damage threshold. In other words, the damage threshold level for glassy clover snail on strawberry was achieved when average number of snail reached 2.5 individual/plant (range 1.25- 3.75) in which chemical control method must be used, while the injury level was about 7.5 individuals /plant (range 3.75-11.25) calculated as the following points for the economic damage threshold where the damage is done when the numbers increased from 3.75 to11.25 individuals/plant ranging 7.5 snail/plant).

Table (1) Damage threshold and injury level for glassy clover snail, *M. cartusiana* (Muller) on strawberry plants under poison baits application during 2015 season

Number of baits	snail no/ 1 m	Yield in kg/m^2	Calculated yield in kg/m^2	Calculated chi square	d.f	Tabulated chi square	
						0.05	0.01
4bait/m	6.25	11.5	10.364				
2bait/m	18.75	8.5	9.102	24.66	1	3.84	6.64
1bait/m	56.25	4.5	5.729				
1bait/2m	112.5	2.5	1.824				
1bait/4m	225	1.4	1.695				
chick	337.5	0.4	0.083				

b =-0.106 SE = 0.018 t =-5.726 ** r= -0.849 * $\hat{y}$ = 11.02- 0.106*X

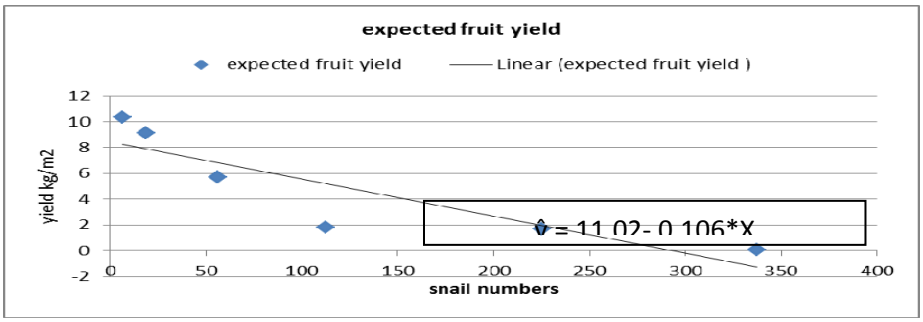


Fig. (1) Linear regression of economic damage threshold and economic injury level for glassy clover snail, *M. cartusiana* on strawberry plants during 2015 season

Using marking plants technique:

The damage threshold of glassy clover snail was studied using marking plants technique where the weekly counts of glassy clover snail on 50 marked strawberry plants were recorded and given in Tables (2&3) and in Fig. (2). The snail fluctuation during the growing season appeared that the snail passes through 2 effective annual peaks, the 1st at March, 20 (x1) showed at the start of harvest season) and the 2nd at April, 10 (x2) showed at the top of harvest curve. Statistical analysis indicated that the considered factors (infestation through two peaks of snail activity) were responsible for 15.6 % of the variability in the yield weight. The reduction in the yield was affected by different manner from one peak to another. The infestation of April peak (x2) showed relatively high effect on yield (b =- 0.038) than in the first peak at March (b=-0.031). Mathematic determination of the point at which the increase of snail number through the two peaks of infestation (x1 and x2) cause a decrease in the weight of fruit yield, chi-square analysis (rx2) was applied. The obtained results indicated that the damage threshold was affected by the two infestation peaks. The population of snails during the 1st peak of infestation at March reach average of 2.5 individual/plant (range 2 to 3 and up), $\chi 2$ indicated highly significant, where the yield was decreased from 1.486 to 1.457 kg/plant this decrease due to the increase of snail numbers to an average of 2.5 individuals /plant which considered as the economic threshold for the 1st peak, so chemical control must be used at this period, while, The economic injury level could be consider as 3.5 individuals /plant (rang 3- 4) . For the 2nd peak of April, the increase of infestation due to average of 2 individuals /plant (range 1 to 3 and up), $\chi 2$ indicated highly significant, where the yield was decreased from 1.556 to 1.484 kg/plant. Thus the increase of snail numbers to an average of 2 individuals /plant could be regarded as the economic threshold for the 2nd peak, the chemical control must be used at this period. The economic injury level in this case was in equal with that of the 1st peak of 3.5 snail/plant (rang 3- 4).

Generally, the obtained results of the two assessment methods cleared that the values of economic damage threshold ETLs were less than economic injury levels EJLs, where the control measurements must be taken on consideration. Therefore, the economic threshold is essential to determine the proper application time of control trial which would causation in successful integrated pest management. The economic damage threshold of *M. cartusiana* on strawberry plants averaged 2-2.5 individual /plant, while the economic injury level averaged 3-7.5 individual/ plant. The obtained results were agree with those of Ibrahim *et al*., 2008 who recorded that the economic threshold level of glassy clover snail on lettuce plants was 3.123 individuals / plant; while it was 3.193 and 3.224 snail/m2 on clover and wheat fields, respectively. In the same study the economic injury levels were relatively high, 37.478 individuals /plant, 17.00 individuals / m2 and 4.38 snail/m2 on lettuce, clover and wheat, respectively. Also, the author showed that the economic damage threshold was 3.58 snail/100 plants and the economic injury level was 12 individuals /100 plant of pea.

Table (2) Yield-infestation relationship in 50 marked strawberry plants under natural infestation with *M. cartusiana* during 2015 season**.**

Plant NO.	Observed yield and snail no.			1 ST Period			2nd Period		
	Fruit yield	x1	x2	x1	Fruit yield	*Predicted fruit yield/plant*	x2	Fruit yield	*Predicted fruit yield*
1	0.975	10	13	0	0.975	1.486	1	0.975	1.556
2	1	7	6	2	1	1.486	3	1	1.484
3	1.125	37	28	2	1.125	1.457	3	1.125	1.484
4	2.15	3	5	3	2.15	1.457	4	2.15	1.449
5	1.475	22	19	3	1.475	1.457	5	1.475	1.416
6	0.775	3	7	3	0.775	1.428	5	0.775	1.416
7	1.025	14	20	4	1.025	1.428	5	1.025	1.416
8	1.15	3	5	4	1.15	1.428	6	1.15	1.383
9	1.225	14	13	4	1.225	1.4	6	1.225	1.383
10	0.8	6	9	5	0.8	1.4	6	0.8	1.383
11	1.2	9	10	5	1.2	1.4	6	1.2	1.383
12	1.1	4	7	5	1.1	1.373	7	1.1	1.352
13	1.325	8	8	6	1.325	1.373	7	1.325	1.352
14	0.575	28	25	6	0.575	1.373	7	0.575	1.352
15	0.95	4	9	6	0.95	1.346	7	0.95	1.352
16	1.175	39	33	7	1.175	1.346	8	1.175	1.321
17	2.45	2	8	7	2.45	1.346	8	2.45	1.321
18	0.85	31	29	8	0.85	1.32	8	0.85	1.321
19	0.975	8	11	8	0.975	1.32	8	0.975	1.321
20	1.55	5	8	8	1.55	1.32	9	1.55	1.292
21	1.125	11	12	8	1.125	1.32	9	1.125	1.292
22	0.45	13	11	8	0.45	1.32	9	0.45	1.292
23	0.475	37	29	9	0.475	1.295	9	0.475	1.292
24	0.975	9	10	9	0.975	1.295	10	0.975	1.263
25	1.1	21	19	9	1.1	1.295	10	1.1	1.263
26	2.125	7	9	10	2.125	1.27	11	2.125	1.236
27	1.2	23	30	10	1.2	1.27	11	1.2	1.236
28	1.075	31	28	11	1.075	1.246	11	1.075	1.236
29	1.3	14	14	12	1.3	1.223	12	1.3	1.209
30	0.825	12	15	12	0.825	1.223	13	0.825	1.184
31	1.325	9	14	13	1.325	1.2	13	1.325	1.184
32	1.825	6	7	14	1.825	1.178	13	1.825	1.184
33	1.825	12	13	14	1.825	1.178	14	1.825	1.16
34	1.2	28	26	14	1.2	1.178	14	1.2	1.16
35	0.975	7	4	14	0.975	1.178	15	0.975	1.136
36	0.675	41	18	16	0.675	1.135	18	0.675	1.073
37	0.825	2	1	21	0.825	1.041	19	0.825	1.054
38	0.975	31	23	22	0.975	1.024	19	0.975	1.054
39	2.15	8	8	23	2.15	1.008	20	2.15	1.035
40	1.15	8	6	24	1.15	0.993	21	1.15	1.018
41	0.975	10	6	28	0.975	0.937	23	0.975	0.987
42	1.05	5	9	28	1.05	0.937	25	1.05	0.96
43	0.6	39	30	31	0.6	0.902	26	0.6	0.949
44	1.65	5	3	31	1.65	0.902	28	1.65	0.928
45	0.85	24	21	31	0.85	0.902	28	0.85	0.928
46	1.775	6	6	37	1.775	0.85	29	1.775	0.9196
47	0.975	14	7	37	0.975	0.85	29	0.975	0.919
48	2.175	4	5	39	2.175	0.838	30	2.175	0.911
49	1.35	16	11	39	1.35	0.838	30	1.35	0.911
50	1.8	8	3	41	1.8	0.828	33	1.8	0.894

Some plants gave unexpected yield because the snail infestation was not only the critical factor of yield in the field

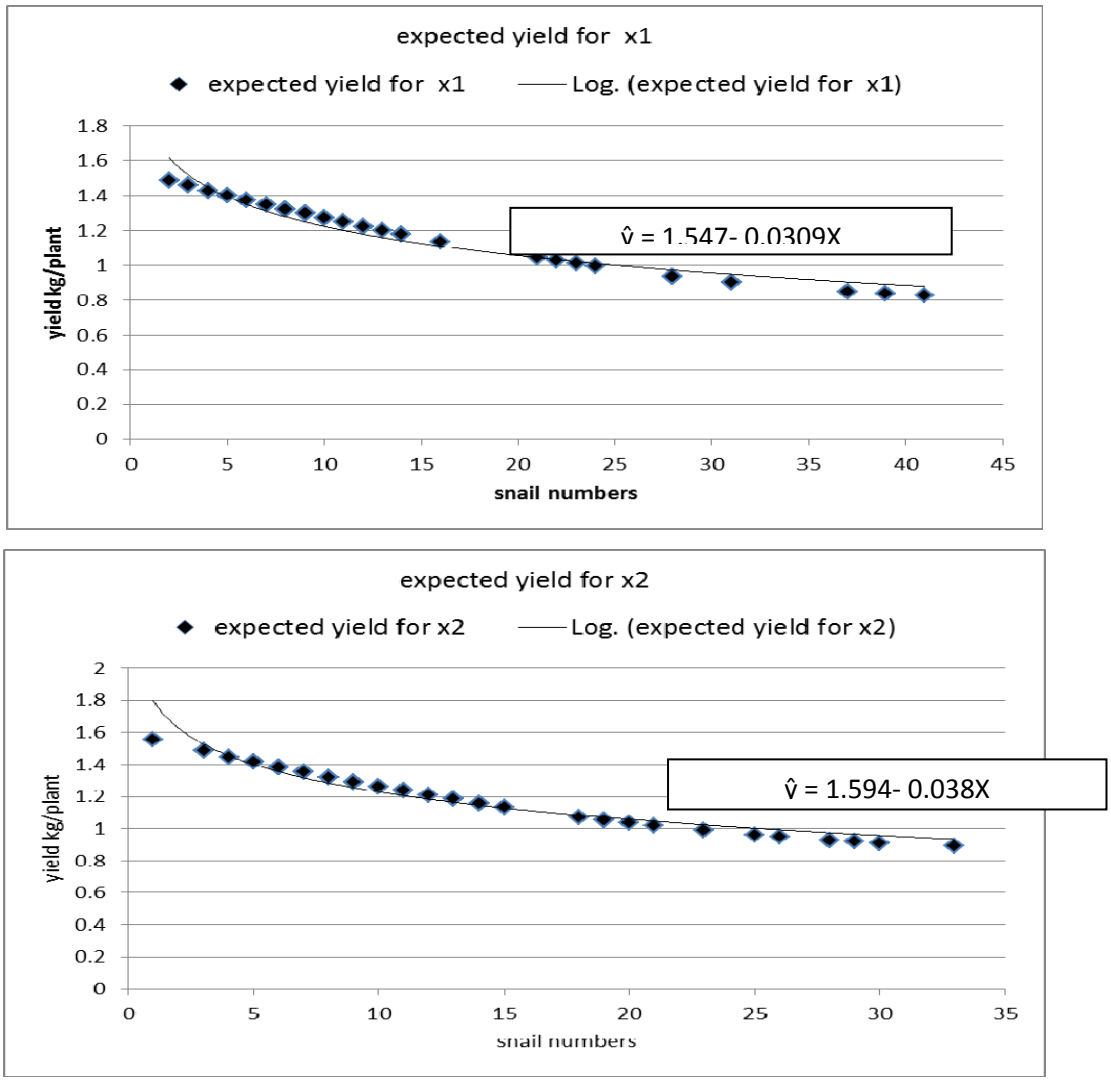


Fig. (2) Total numbers of *Monacha cartusiana* at the first (x1) and the second (x2) annual peaks.

Table (3) Statistical analysis simple correlation(r) and partial regression (b1&b2) for the relationship between *M. cartusiana* peaks count and the yield of 50 marked strawberry plants (fruits weight) during 2015 season.

Variables	Simple correlation(r)		Partial regression				Explained variance
	r	probability	b	S.E	t	probability	EV%
snail no./ plant (x1)	-0.426	< o.o1	-0.0309	0.023	-1.345	*	19.6
snail no./ plant (x2)	-0.389	< o.o1	-0.038	0.0328	-1.166	ns	15.7

r = correlation coefficient, b = Partial regression values, x1= 1st peak and x2 = 2nd peak

Food consumption and preference of *M. cartusiana* to strawberry cultivars under laboratory conditions:

Two experiments were conducted to compare food preference and consumption of *M. cartusiana* fed on three parts (fresh leaves, green fruits and complete red fruits) of strawberry tested cultivars (Proprietary, Festival and Camarosa) under laboratory conditions. The first experiment carried to examine

preference of three plant parts of each cultivar by feeding snails on the three plant parts of each cultivar at the same time, the obtained data in Table (4) showed highly significant differences between quantity means of each cultivar parts consumed by *M .cartusiana*, where LSD 0.05 recorded 2.82, 3.46 and 1.997 for Proprietary, Festival and Camarosa cultivars, respectively. The glassy clover snail , *M. cartusiana* preferred green fruits of Proprietary more than other parts (consuming 32.1 mg/snail at the first day); while preferred red fruits of each of Festival (consuming 29.63 mg/snail at the 2nd day) and Camarosa (consuming 35.56 mg/snail at the 1st day).

The second experiment carried out to examine preference of the three tested cultivars by feeding snail on each plant part of the three cultivars at the same time. The obtained data in Table (5) showed that, highly significant differences between quantity means of each parts consumed by *M .cartusiana*, where, LSD $_{0.05}$ of 2.82, 3.99 and 4.315 in case green fruits, red fruits and fresh leaves, respectively. The green and red fruits of festival cultivar were preferred by *M. cartusiana* (consuming mean quantity of 19.06 and 39.02 mg/snail of the two parts, respectively) more than that of Proprietary and Camarosa cultivars; while the fresh leaves of Camarosa were more preferred by *M .cartusiana* (consuming mean quantity of 19.99 mg/snail).

Generally, it could be concluded that the food preference of *M. cartusiana* on three parts (green fruits, red fruits and fresh leaves) of strawberry tested cultivars (Proprietary, Festival and Camarosa) under laboratory conditions was varied as plant part and cultivar, where *M. cartusiana* snail found preferred red fruits of Festival, green fruit of Proprietary and fresh leaves of Camarosa more than other tested food. The results provide clear discussion about the quantitative and qualitative damage resulted on strawberry yield and emphasizes the need to study and use the economic threshold levels of the pest on strawberry. The obtained results found agree with those of Stakious and lazardious-Dimitriadous (1989), Lokma (1998), Abd El-Aal (2001), Ismail (2004), Lokma (2013) who stated that the food preference and consumption was varied as host plants and plant parts variation especially that of Lokma (2013) who mentioned that the highest quantity consumed by *M. cartusiana* of strawberry red fruits was 74.06 mg/day followed by leaves and green fruit with quantity of 51.85 and 38.20 mg/day, respectively.

Table (4) plant part preferences as daily food consumption (mg/snail/day) per one adult of *M. cartusiana* fed on the three plant parts under laboratory condition (Temp. 25±1ºC and RH 65± 5 %).

Cultivars	Host plant	Consumed weight (mg) after days			means	LSD $_{0.05}$ for days
		1	2	3		
Proprietary	Green fruits	32.10	28.66	24.29	28.35	**0.07*** **
	Red fruit	12.43	14.49	14.48	13.8	**0.01*** **
	Fresh leaves	14.20	15.15	14.67	14.67	**0.12*** **
LSD		**0.07*** **	**0.11*** **	**0.01*** **	**2.82*** **	
Festival	Green fruits	19.47	15.98	18.44	17.96	**0.02*** **
	Red fruit	19.04	29.63	28.51	25.72	**2.67*** **
	Fresh leaves	14.94	18.47	15.31	16.24	**2.07** **
LSD		**1.95*** **	**2.49*** **	**1.19*** **	**3.46** **	
Camarosa	Green fruits	18.97	18.77	16.18	17.97	**1.25** **
	Red fruit	35.56	30.45	28.33	31.44	**2.07*** **
	Fresh leaves	18.37	23.33	13.20	18.3	**1.28*** **
LSD		**1.69*** **	**1.43*** **	**1.62*** **	**1.99*** **	

Table (5) host preference as daily food consumption (mg/snail/day) by one adult of *M. cartusiana* fed on the three strawberry cultivars under laboratory condition (Temp. 25±1ºC and RH 65± 5 %).

Cultivars	Host plant	Consumed weight (mg) after days			means	LSD
		1	2	3		
Green fruits	Proprietary	18.70	9.41	5.34	11.15	**7.88***
	Festival	20.28	21.33	15.58	19.06	**ns**
	Camarosa	15.22	20.66	21.01	18.96	**ns**
LSD		**ns**	**8.56***	**8.72***	**2.82*****	
Red fruits	Proprietary	27.40	31.81	29.21	29.47	**ns**
	Festival	66.39	27.46	23.21	39.02	**ns**
	Camarosa	28.44	62.18	23.59	38.07	**ns**
LSD		**ns**	**ns**	**ns**	**3.99****	
Fresh leaves	Proprietary	16.87	12.42	13.63	14.31	**ns**
	Festival	17.61	15.31	9.38	14.10	**ns**
	Camarosa	21.94	20.89	17.16	19.99	**ns**
LSD		**ns**	**ns**	**ns**	**4.315***	

REFERENCES

Abd El-Aal, S. M. (2001): Studies on certain land snails at Sharkia Governorate. M.Sc. Thesis, Fac. Agric., Zagazig Univ. 160 pp.).

Arafa, A. A. I. (1997): Studies on some land molluscs at Sharkia Governorate. M.Sc. Thesis, Fac. Agric., Al-Azhar Univ., 137 pp.

Bardner, R. and K. E. Fletcher (1974): Insect infestation and their effects on the growth and yield of the fields crops a review. Bull. Ent. Res. 64: 141-160.

Chang, H. W. (1991): Food preference of the land snail *Cepaea nemoralis* in a North American population. Malacological Res., 24 (1–2): 107–114.

El-Massry, S.A.A. (1997): Studies on the control of some land snails infesting certain fruit trees. Ph. D. Thesis, Fac. Agric., Zagazig Univ., 150 pp.

El-Okda, M. M. K. (1980): Land snails of economic importance on vegetable crops at Alexandria and neighboring regions. Agric. Res. Rev., 58 (1): 79 – 85.

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

Ghamry, E. M.; Kokab, Y. Amer and B. M. Wilson (1994): Screening test of some insecticides against the two land snails *Monacha contiana* and *Eobania vermiculata* in Sharkia Governorate. Zagazig. J. Agric. Res., 21 (5): 1539 – 1545.

Hosny, M.M.; A.H. Amin and G.B. El-Saadany (1972): The damage threshold of the red scale, *Aonidiella aurantii* (Mask) infesting mandarin trees in Egypt. Bull. Soc. Ent., Egypt, 71:286-296.

Ibrahim, M. M. A. (1994): Ecological and biological studies on some pests of solanaceous plants at Sharkia Governorate, M. Sc. Thesis, Fac. Agric. Zagazig University, 200 pp.

Ibrahim, M.M.A. (2001): Studies on some piercing –sucking insect pests infesting cotton plants. Ph.D. Thesis, Fac. of Agric. Zagazig Univ.198 pp.

Ibrahim, M. M. A.; Sh. A. A. Ismail; H. E. Megahed and S. A. A. El-Massry (2008): Economic threshold and injury levels of land snail *Monacha cartusiana*

(Muller) infested some vegetable and field crops at Sharkia Governorate, Egypt. .Egypt, j. agric. Res., 86(1), 65-75.

Ismail, Sh. A. A. (1997): Ecology, biology and control of certain terrestrial snails infesting some vegetable and field crops in Sharkia Governorate. Ph.D. Thesis, Fac. Agric., Zagazig Univ., 130 pp.

Ismail, Sh. A. A. (2004): Ecobiological studies on the brown garden snail *Eobania vermiculata* Muller under laboratory and field conditions in Sharkia Governorate. Zagazig J. Agric. Res., 31(1): 293-305.

Kassab, A. and H. Daoud (1964): Notes on the biology and control of land snails of economic importance in the U.A.R. J. Agric. Res. Rev., Cairo, 42: 77-98.

Little, T. M. and F. J. Hills (1975): Statistical methods in agricultural research available from U.C.D. Book store, Univ. of California, Davis: 241pp

Lokma, H. E. (1998): Food bait preference and consumption of some land snails in K.S.A. (Saudi Arabia). Zagazig J. Agric. Res., 25(2): 321-326.

Lokma, M.H.E. (2013): Studies on some terrestrial mollusks injurious vegetables and field crops in East Delta locality (Sharkia and Ismailia). Ph.D. Thesis, Fac. Agric., Benha Univ., 179 pp.

Mohamed, R. Ghada (2004): Ecological studies on some species of snails. M.Sc. Thesis, Fac. Agric., Benha Univ. Egypt, 215 pp.

Nakhla, J. M.; M.A. Rizk and A.W. Tadros (1995): Host preference of land snails as indicated by plant cells in their excrement. Egypt. J. Agric. Res., 73 (1): 95 – 109.

Pedigo, L. P.; S. H. Hutchins and L. G. Highly (1986): Economic injury levels in theory and practice. Ann. Rev. Ent. 31: 341-368.

Salem, S.A. and Zaki, F.N. (1985): economic threshold level of the citrus wax scale *Ceroplastes floridensis* Comstock on citrus Egypt. Bull. Soc. Ent. Egypt, 05, 1984-1985 (333-344)

Stern, V. M.; R. V. Smith; R. V. D. Vosish and S. F. Gen (1959): The integrated control concept. Hilgardia, 29: 81-101.

Stakious, A. and lazardious-Dimitriadous, M. (1989): Effect of crowding on growth and mortality in the edible snail *Helix lucorum* (Gastropoda: Pulmonata) in greece. Israel.J. Zool. 36(1): 1-9.

ARABIC SUMMARY

مستويات الضرر والحد الاقتصادي الحرج والتفضيل الغذائي لقوقع البرسيم الزجاجي الذي يصيب نباتات الفراولة في محافظة الاسماعيلية – مصر

محمد محمد احمد ابراهيم ، محمد حسن عصام لقمة ، محمد عبدالله عيسى
معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – مصر

اجريت الدراسة في قرية المحسمة – مركز القصاصين محافظة الاسماعيلية خلال موسم ٢٠١٥ بهدف البحث لتقدير مستويات الضرر الاقتصادي والحد الاقتصادي الحرج لقوقع البرسيم الزجاجي الذي يصيب نباتات الفراولة وذلك بنظام الاصابة الطبيعية واستخدام الطعوم السامة . كما تم اجراء تجربة معملية لدراسة التفضيل الغذائي لقوقع البرسيم الزجاجي علي ثلاث اصناف من الفراولة (فستيفال ، كماروزا ، منتخب).

اوضحت نتائج تقدير مستويات الضرر الاقتصادي والحد الاقتصادي الحرج ان قيم الحدود الحرجة للاصابة كانت اقل من حدود الضرر حيث يجب تطبيق اجراءات المكافحة ، لذلك فان اهمية الحد الاقتصادي الحرج تتمثل في تحديد الوقت الامثل للتدخل باجراءات المكافحة والتي تضمن نجاح برنامج المكافحة المتكاملة للافة . وكان الحد الاقتصادي لحرج ٢-٣ قوقع /نبات بينما تراوح حد الضرر الاقتصادي من ٣-٧ قوقع/نبات

اظهرت نتائج التجارب المعملية ان التفضيل الغذائي لقوقع البرسيم الزجاجي قد اختلف تعا لاختلاف الاجزاء النباتية والاصناف المقدمة للتغذية عليها حيث وجد ان القوقع يفضل الثمار الحمراء لصنف فيستيفال(٣٩.٠٢ جم/قوقع/يوم) والثمار الخضراء لصنف منتخب (٢٨.٣٥ جم/قوقع/يوم) والاوراق الطازجة لصنف كماروزا (١٩.٩٩ جم/قوقع/يوم).