ECONOMIC THRESHOLD AND INJURY LEVELS OF LAND SNAIL *MONACHA CARTUSIANA* (MULLAR) INFESTED SOME VEGETABLE AND FIELD CROPS AT SHARKIA GOVERNORATE, EGYPT

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(Manuscript received 4 June 2007)

Abstract

The designed experiments were carried to calculate the economic threshold levels (ETLs) and economic injury levels (EILs) for the more existed land snail species *Monacha cartusiana* (Mullar) in wheat, clover, pea and lettuce fields at Sharkia governorate throughout winter season of 2006/2007.

The gained results proved that the economic threshold and injury levels were varied significantly for different tested crops.

The relatively highest economic threshold level of 3.123 snail/plant was recorded on lettuce plants followed by 3.58 snail/100 plants of pea, while in case of clover and wheat crops were 3.193 and 3.224 snail/ m^2, respectively.

As economic injury levels, the values were raised than that of ETLs recording the highest level of 37.478 snail/plant of lettuce followed by 17.00 snail/m^2 on clover plant and 12.00 snail/100 plant of pea while on wheat the EIL was 4.38/m2. Therefore, it could be concluded that the lettuce plants were more tolerant to land snails infestation than other tested plants, while pea plants were the susceptible ones.

INTRODUCTION

Recently the land snails become one of the major serious pests in different field, vegetable, fruit and ornamental crops in Egypt, especially in northern Governorates of Delta region. The land molluscs were inspected with a relatively high population density attacking various crops causing great direct damage to all plant parts, chewing soft vegetative growth, flower, roots and tubers or indirect damage by left viscous liquids upon the plants making humans and farm animals refuse eating on these plants (El-Okda, 1980). Therefore, the total income and benefits of yield of infested vegetable crops are decrease economically. The snail species, *Monacha cartusiana* was reported as a dominant species in different districts of Sharkia Governorate (Ghamry, *et al* 1994, Nakhla, *et al.* 1995, Arafa, 1997, Ismail, 1997 and El-Massry, 1997).

The use of economic thresholds as a basis for 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 (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 snails relationships, and much has been done towards developing damage assessment models and computing (Kassab and Daoud, 1964, El-Okda, 1984, Chang, 1991, El Massry, 1997 and Ismail, 1997).

So, the objective of this study is to estimate economic injury and threshold levels for land snail, *Monaca cartusiana* as bases for decision making recommendation for the pest control programs of different crops fields.

MATERIALS AND METHODS

An experimental area of half feddan was chosen for each tested crop at Zagazig district, Sharkia Governorate, to conduct the proposed studies.

A factorial design with three replicates for each treatment was used during the crops growing season of winter 2006-2007. The tested parameters were crop species and land snail densities. The artificial infestation technique of Ibraheem (1993) was used under field cages as snail levels on each tested plant species in (Table, 1).

The used cages on wheat and clover were, 1 × 1 × 1.5 m as width × length × height, respectively, using plastic pipes covered by small-mesh clothes. On pea and lettuce, the iron cages were 30 × 30 × 150 cm as width × length × height, covered using small-mesh cloths.

Table 1. Artificial infestation levels of *Monaca cartusiana* snails introduced on different tested plants under field cages during winter growing season of 2006-2007.

Crops	Infestation unit	Artificial infestation levels					Plant age at infestation time (days)
		1	2	3	4	5	
Wheat	m^2	0	20	30	40	50	35
Clover	m^2	0	12	24	48	96	35
Pea	plant	0	1	2	4	6	30
Lettuce	plant	0	10	20	30	40	20*

* after transplanting of seedlings

Using cage for establishment of artificial population can disrupted damage plant growing in a canopy inside the field plots. Therefore, screen mesh size was as large as possible to minimize microclimatic changes while confining the pest (Poston *et al.*, 1985). The chosen plants and around ground area free from infestation were caged and the snails at different levels were introduced on the plants of each plant species replicates. The snails were collected from land snails heavy infested area around the experimental area.

The snails numbers on plants of each infested cage were counted early morning after four days from infestation starting to inspect and count the snail which were still on plants till harvest. The normal agricultural practices were applied. In case of clover plants, the observations continuous till cutting time and the snails were kept under cages.

The yield of tested crops unites were estimated as following

1- The yield of wheat was determined as mean of grain weight per plant.
2- The yield of clover was deduced as weight of the three principals cuts per one m as g/m
3- Pea yield was calculated as mean yield of buds weight per plant
4- The yield of lettuce as ton/kirat.

The percentage of yield reduction (R %) was calculated using the next formula:

$$R\ \% = \text{control} - \text{infested} / \text{control} \times 100.$$

Determination of economic injury levels (EILs)

To compute EIL, there are some parameters must be estimate: rate of yield reduction, cost of land snail control measurements and market price of the crop unite. Also, the regression model for the yield-land snail relationship was deduced using regression line formula: $y = a \pm bx$, where: y = expected yield,
a = y intercept, a = constant representing the average yield of non infested plants, b = slope of regression line, x = the number of transferred snails to plant. To clear the relationship, gain threshold was calculated according to **Ston and Pedigo** (**1979**) formula:

Gain threshold (GT) = pest control cost (L.E/Fed.) / crop unit market price

Gain threshold means the amount of yield loss that constitutes minimum economic damage.

In this study, chemical control cost (CC/fed) was estimated using the native molluscicide, Lannite 90 % (w.p) at rate of 300 gm/fed have 2 % concentration, two parts of Lannite (300 gm/fed.) + five parts of molasses (one kg/fed.) + 95 parts of bran (15 kg/fed.). Baits were distributed around the target field in 150 bait station. Each bait station was a piece of plastic sheet 20 × 20 cm, 100 g of the poisonous bait was placed on each bait station.

The total calculation costs for one feddan treatment was 129.25 LE according to the marketing price on that time. This costs include labor wags (who distributed the poisonous baits and collected the died snails). Table 2, show the total prices of the different components of the applied materials at that time in Sharkia Governorate.

Table 2. Gain threshold values computed as control cost (poisonous bait/fed. costs) and crops unit marketing price at Sharkia Governorate winter growing season of 06/07.

Crops	Marketing unit	Marketing price L.E (MP)	Total control cost L.E (CC)	Gain threshold (G.T) CC/MP
Wheat	Ardab	170	129.25	0.760
Clover	Ton	200		0.646
Pea	100 kg	135		0.957
Lettuce	Ton	150		0.862

Marketing unit and price conducted as native use in different location of Egypt.

Determination the economic threshold level (ETL)

To deduce the ETls of snails infesting tested crops, the general model of Chiang (1979) was applied:

$$ETL = [CC/(EC \times Y \times P \times YR \times SC)] \times CF.$$

Where:

CC = the cost of chemical control (L.E/Fed.)

EC = % efficiency of used pesticide

Y = the yield in marketing unites/fed.

P = the price of crop unite (Table, 2)

YR = % yield reduction resulting as snail infestation effect

$$YR = (yc - yt/yc) \times (100/\text{snail no.})$$

Where:

Yc = average yield of control (non infested) treatment

Yt = average yield of infested treatments

Sc = the survival coefficient = 1 (because the all stages of snails cause damage for plants.

Cf = 1 (the critical factors) this factor considers the socio economic judgment, it can be adjusted according to environment suitability by varying the c.f. between 1 and 2 c.f have the 1 under favorable conditions to the snail and prepared to waste the control, should the ecological conditions be adverse to the snail. However, for the minimum environment impact, c.f should have the value 2. The ET is thus aimed at compute the cost of control under adverse ecological conditions (Chiang, 1979). The ET will be in terms of snail population density.

Statistical analysis trials were carried out using Costat 6.311 for windows computer program.

RESULTS AND DISCUSSION

The economic damage threshold is the level of pest population at which integrated control measures must be under taken to prevent the population from reaching the level that cause economic damage to the crops, i.e. the Economic Injury Level (EIL) Stern *et al.* (1959).

In this study, the economic damage threshold and injury levels were determined using artificial infestation technique under cages.

1- Economic injury levels (EILs)

Artificial infestation was carried out using mature snails collected from land snail heavy infested area around the experimental area. At indicated times shown in Table (1), five levels of snails densities were established on tested crops. The gain threshold values for snails on tested crops given in Table (2). The obtained results of tested crops were subjected as follows:

Data present in Table (3) and illustrated in Fig. (1) show that the regression and correlation analysis between each of tested crops yields (dependant variables) and snails densities (independent variables) resulted in highly significant correlation coefficients, r = - 0.993, -0.781, -0.960 and -0.998 for the tested crops, wheat, clover, pea and lettuce, respectively. Highly significant variations were observed between mean yields of each crop as responsible to different snails densities (as artificial infestation levels) and control ($P < 0.01$).

As gain threshold values in Table (2) and application of regression model for yield – snails relationships according to Ogunlana and Pedigo (1974) the economic injury level for snails infested different tested plants as numbers of snail/plant (on pea and lettuce plants) or numbers of snails/m^2 (in wheat and clover fields) that would reduce the yield by 0.76 ardab wheat, 0.646 ton clover, 0.957 sac pea (sac weight 100

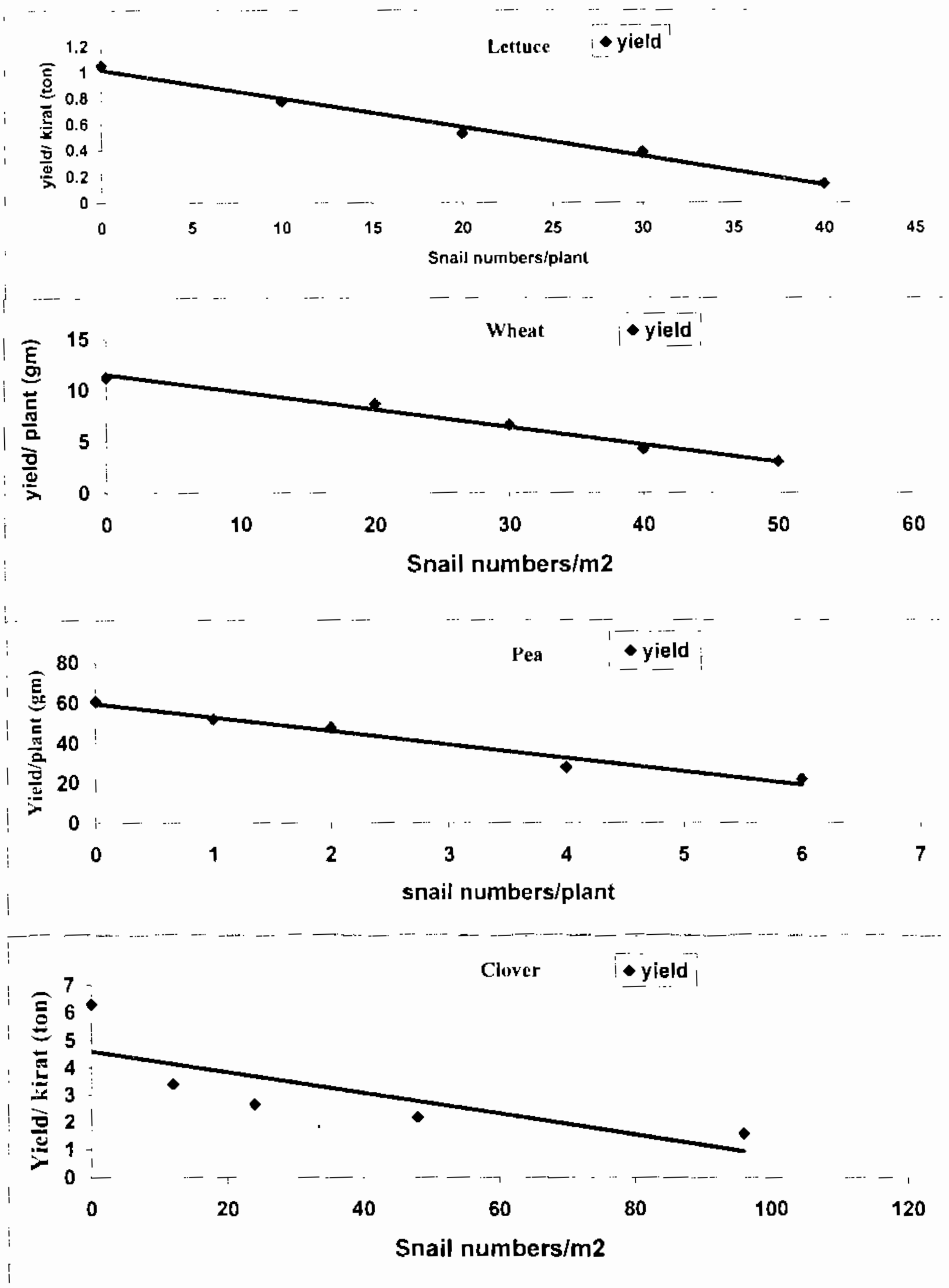

Fig. 1. Linear regression of crops yield on numbers of land snail, *Monacha. cartusiana* transmitted to caged plants during 2006-2007 season.

kg pea) and 0.862 ton lettuce. Because y = a + bx it follows that bx = y – a = - (a-y) but (a-y) is the reduction of gain threshold values (GT) (Table, 2) that intercept minus the expected yield.

Therefore, it could be deduced the economic injury levels as (x) values (number of snails) on different crops as follows:

Table 3. The economic injury levels of snails infested, wheat, clover, pea and lettuce crops at Zagazig region, Sharkia Governorate during 2006-2007 winter season.

Crops	G.T (a-y)	b	EILs X = (a-y)/b	Linear regression equation y = a - bx
Wheat	0.760	- 0.171	4.38≈4.0	y= 11.54 - 0.171x
Clover	0.646	- 0.038	17.0	y= 4.582 - 0.381x
Pea	0.957	- 0.968	0.12≈1	y= 64.725 - 7.968x
Lettuce	0.862	- 0.023	37.478	y= 70.299 - 0.023x

(a-y) = gain threshold, b = slop, x = number of snails present EILs

2. Economic threshold levels (ETLs)

According to Stern (1966 and 1973), the economic threshold level is the density of pest which control measures should be detected to prevent an increasing pest population from reaching the economic injury level. However, the economic threshold is lower than economic injury level to permit sufficient time for the initiation of control measures.

The ETLs were deduced for land snails on tested crops using general model of Chiang (1979) as follow:

To compute the economic threshold levels for snails on different crops it must be detected as formula items as Table (5), the cost of control (CC), Efficacy of control (EC) as Ismail (1997), yield reduction/one individual of snail (YR) Table (4), The price of crops (P) Table (2), the survival coefficient (Sc = 1), where the all developmental stages caused damage. The critical factor (Cf = 1) (Socio economic judgment) and yield of feddan (Y) Table (5).

Table 4. Estimate the yield reduction by one individual of snail (YR).

Crops	Levels	Snail density (x)	yu	yt	Lp= yu-yt	Σ LP	Σx	LiP ΣLP/Σx	YR= LiP x 100/yu
Lettuce	1	10	70.61	56.88	13.73	123.8	100	1.238	1.75
	2	20		46.225	24.38				
	3	30		35.53	35.08				
	4	40		20.00	50.61				
Pea	1	1	60.5	51.70	8.80	93.46	13	7.187	11.88
	2	2		47.60	12.90				
	3	4		27.55	32.95				
	4	6		21.69	38.81				
Clover	1	12	0.63	0.338	0.292	1.543	180	6085	1.349
	2	24		0.265	0.365				
	3	48		0.216	0.414				
	4	96		0.158	0.472				
Wheat	1	20	11.23	8.65	2.58	22.42	140	0.16	1.426
	2	30		6.6	4.63				
	3	40		4.25	6.98				
	4	50		3.00	8.23				

Table 5. Calculated of economic threshold levels of snails infested tested crops as mean number at Zagazig region, Sharkia Governorate during 2006-2007 winter season.

Crops	CC	EC	YR	P	Y	SC	c.f.	ETLs
Lettuce	129.25	75.0	1.75	150	21.02	1	1	3.123/plant
Pea			11.85	135	300			3.38/100 plant
Clover			1.149	200	20			3.193/m^2
Wheat			1.426	170	22.05			3.224/m^2

ETLs = [CC/(EC × Y × P × YR × SC)]x C.F.

Generally, the obtained results revealed that the values of economic threshold levels ETLs were less than economic injury levels, where the control measurement must be under taken. Therefore, the economic threshold is essential to determine the application time of pesticides control trial which would resulted in successful integrated pest management. The relatively highest economic levels were recorded on lettuce plants tended to clear that the lettuce plants more tolerant to *M. cartusiana* infestation, while pea plants were more susceptible than other tested crops.

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الحدود الاقتصادية الحرجة وحدود الضرر لقوقع البرسيم الزجاجي الذي يصيب بعض محاصيل الحقل و الخضر في محافظة الشرقية – مصر

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أصبحت القواقع الأرضيه فى الآونه الأخيرة من أكثر الآفات التي تصيب محاصيل الحقل والخضر والفاكهة و الزينة خطورة في مصر. ويعتبر استخدام الحدود الاقتصادية كأساس لاتخاذ قرار اجراءت المكافحة من الأهمية بمكان فى المكافحة المتكاملة للآفات على مختلف المحاصيل.

وتهدف هذه الدراسة لحساب الحدود الاقتصادية الحرجة والحدود الاقتصادية للضرر لقوقع البرسيم الزجاجي فى حقول محاصيل القمح والبرسيم والبسلة والخس وذلك بإتباع طريقة العدوى الصناعية.

وأوضحت النتائج أن هناك اختلافات معنوية فى قيم الحدود الاقتصادية الحرجة والحدود الاقتصادية للضرر على المحاصيل المختلفة. وكانت أعلى الحدود الاقتصادية الحرجة نسبيا ٣,١٢٣ قوقع/نبات على نباتات الخس يليه ٣,٥٨ فرد/١٠٠ نبات بسلة بينما فى حالة القمح والبرسيم فكانت ٣,٢٢٤ ، ٣,١٩٣/متر مربع على التوالي.

أما بالنسبة لحدود الضرر الاقتصادي فكانت القيم اكبر من تلك الخاصة بالحدود الاقتصادية الحرجة حيث سجل أعلى قيمة ٣٧,٤٧٨ قوقع/نبات كأعلى مستوى على نباتات الخس وتلاه ١٧,٠٠ قوقع/متر مربع على نباتات البرسيم بينما سجل متوسط ١٢,٠٠ فرد/١٠٠ نبات على محصول البسلة وسجل ٤,٣٨ فرد/متر مربع على القمح ومن هنا يمكن القول ان نباتات الخس كانت أكثر المحاصيل المختبرة تحملا للإصابة تلاها البرسيم ثم القمح وكان أكثرها حساسية للإصابة نباتات البسلة.