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INTEGRATED CONTROL USING DIFFERENT METHODS AGAINST TWO LAND SNAIL SPECIES *Theba pisana* (Muller) AND *Helicella vestalis* (Pfeiffer) INFESTING *Citrus nobilis* TREES AT SHARKIA GOVERNORATE

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ABSTRACT

Number of field experiments were conducted to evaluate the efficiency of certain safe and non- safe control methods as components of integrated pest management which help in reducing the population density of two land snail species, *Theba pisana* and *Helicella vestalis* infesting mandarin (*Citrus nobilis*) trees in orchards at newly salhyia, Sharkia Governorate during 2010- 2011. The safe methods were agricultural control (Tillage or plowing process and plant traps) and mechanical control (hand picking) for six weeks. The non-safe methods were chemical control by some toxicants (glyphosate: Herbicide, carbofuran: Insecticide and nematicide, chlorpyrifos-methyl: Insecticide, methamidophos: Insecticide, paraquate: Herbicide) and biological control by Xentari : *Bacillus thuringiensis* (B .T.) : Biocide and Insecticide.These toxicants were prepared as wheat bran baits for three weeks. The tested IPM components reduced the snail population of both species depending on their efficiency and the time of performance. Tillage, plant traps, toxicants and hand picking were useful to control land snails during December and January 2010, February and March 2011, April, June and July successively. Results revealed that glyphosate was the most effective toxicant giving highest average values of reduction percentage (58.02% and 61.4%) followed by tillage process (53% and 45.5%), plant traps (44.7% and 52.7%) and hand picking (37.9% and 45.2%) for *Theba pisana* and *Helicella vestalis* respectively, at the end of experiments. The biocide xentari (*Bacillus thuringiensis*) was the least effective one (31.9% and 32.02%). Moreover, the descending order of the tested toxicants was, glyphosate, carbofuran, chlorpyrifos-methyl, methamidophos, paraquate and Xentari.

INTRODUCTION

During last few years land snails are becoming serious pest in Egypt. These animals attack the different kinds of plants, cereal, vegetables, fruit orchards and ornamental plants at the different growth stages reducing their production (El - Okda, 1980). Furthermore, in some crops the significance of land snail gastropods are only now becoming apparent with the decline in the importance of other pest groups such as insects, for which effective control strategies have been developed (Barker, 2002). The first step in an integrated approach to control this pest is the application of molluscicides to reduce the land snail population (Barker, 2002). In orchards the application of molluscicides is the most critical initial step for controlling of land snails in their outbreak time but their residual populations controlled with other methods i.e. agricultural, mechanical and natural control (Barker, 2002). The

present work aims to throw light on the obvious role of agricultural, mechanical, chemical as well as biological managements to control *T. pisana* and *H. vestalis* inhabiting some orchards at newly salhyia, sharkia Governorate.

MATERIALS AND METHODS

Safe control methods:

A- Agricultural control:

1- Tillage process

The impact of tillage process was evaluated as one of agricultural control methods used for reducing population of the land snails. The experiment was conducted during egg- laying period 2010 at newly salhyia, Sharkia Governorate. An area of about half- feddan cultivated with *Citrus nobilis* trees heavy infested with the land snails *T. pisana* and *H. vestalis* was chosen and divided into two plots, the first one was subjected to plowing using disk harrow and the second one was left without any process as control. Four replicates in each plot were carried out. Each replicate contained three trees. Individuals of the land snails *T. pisana* and *H. vestalis* were counted in the early morning in a quadrate of 50 x 50 cm on the soil surface under one tree randomly chosen in each replicate and on the lower portion of the trunk to about one meter height in treated and untreated plots. Population counts were carried out 24 hours before plowing and then at weekly intervals for 6 weeks starting from December, 2011. The reduction percentages were calculated according to the formula of Henderson and Tilton 1955 as follows:

% Reduction = $100 [1 – t_2 r_1/t_1 r_2]$ Where:

r_1 = number of alive snails before treatment in untreated plots.

r_2 = number of alive snails after treatment in untreated plots.

t_1 = number of alive snails before treatment in treated plots.

$_{t2}$ = number of alive snails after treatment in treated plots.

2- Plant traps

The role of plant traps as cabbage: *Brassica oleracea* in reducing population density of *T. pisana* and *H. vestalis* infesting *C. nobilis* orchards was studied during February and March, 2011 at the same area which was previously used in tillage .This area was divided into two plots. The first plot was cultivated with cabbage at rate of 8 plants between each two trees while, the other plot was left without cabbage as control. Four replicates in each plot were carried out. Each replicate contained three trees. Individuals of both species were counted in the early morning in a quadrate of 50 x 50 cm on the soil surface under one tree randomly chosen in each replicate and on the lower portion of the trunk of the same tree to about one meter height in treated and untreated plots. Population counts were carried out 24 hours before cabbage cultivation and then at weekly intervals for 6 weeks. On the other hand, all snails on cabbage plants were collected and removed every two days through the duration of the experiment. The reduction percentages were calculated according to the formula of Henderson and Tilton 1955.

B- Mechanical control:

Hand picking of land snails

The effect of hand picking in reducing population density of *T. pisana* and *H. vestalis* snails was calculated during June and July, 2011 in aestivation period. This study was carried out in a field of *C. nobilis* heavy infested with the two land snail species at the same area which was previously used in tillage and plant traps experiments. This area was divided into eight plots each had about eight trees. Four plots were subjected to hand picking application by workers during the day hours from 12 A.M (Ante meridiem) to 6 P.M (Post meridiem) five days after irrigation, while the other plots were left without hand picking. Snails were counted in a randomly choosen quadrate size 50 x 50 cm on the soil surface under the trees and on the lower portion of the trunk at about one meter height before one day and then after weekly intervals for six weeks. The reduction percentage of population density was calculated according to the formula of Henderson and Tilton (1955).

Non – safe control methods:

A- Chemical control:

Carbamate compound:

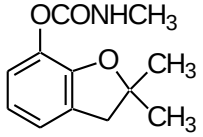
Carbofuran: Insecticide and nematicide.

Trade name : furadan 10% G

Common name: carbofuran

Chemical name: 2,3 dihydro-2,2-dimethyl-7-benzofuranyl methyl carbamate.

Structural formula:



Organophosphorous compounds:

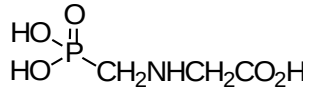
1- Glyphosate: Herbicide

Trade name: Round up 48 % WSC

Common name: glyphosate

Chemical name: (Phosphonomethyl) glycine

Structural formula:



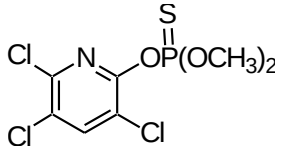
2- Chlorpyrifos-methyl: Insecticide

Trade name : Reldan 50 % EC

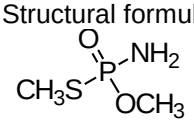
Common name: chlorpyrifos **-** methyl

Chemical name: O,O- dimethyl O- (3,5,6- trichloropyridyl) phosphorothioate.

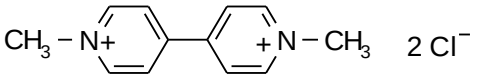
Structural formula:



3-Methamidophos: Insecticide
Trade name: **Tamaron 60% EC**
Common name: methamidophos
Chemical name: O,S – dimethyl phosphoramidothioate.
Structural formula:



Bipyridylium compound:
Paraquat: Herbicide
Trade name: **gramoxone 20% EC**
Common name: paraquate
Chemical name: 1,1- dimethyl**–** 4,4 bipyridilium dichloride
Structural formula:



B- Biological control:
Xentari: Biocide: Insecticide
Trade name: Xentari 3% WDG
Common name: *Bacillus thuringiensis* (B .T.)
These samples were supplied by Central Agricultural Pesticides Laboratory, Dokki, Egypt.

Field experiment:

The experiment was carried out during April in *C. nobilis* farm highly infested by the land snails *T. pisana* and *H. vestalis* at the same area which was previously used in tillage, plant traps and hand picking experiments .The tested toxicants were applied as poisonous wheat bran baits at the concentration 2% of each toxicant. The applied concentration was prepared by incorporation of the tested toxicant into bait formulation consisted of sugar cane syrup and wheat bran (2 parts toxicant + 5 parts of sugar cane syrup + 93 parts of wetted wheat bran) with three replicates (four trees / replicate). The control treatment was designed by the same manner without any toxicant. Baits were laid on plastic trays 30 x 30 cm (each contained 80 gm) placed under each replicate trees. The expected reduction percentage values were calculated for each toxicant according to the formula of Henderson and Tilton (1955).

Statistical analysis:

The analysis of variance was computed using Costat computer program Cohort Software.P.O. Box 1149, Berkeley CA 9471 (Costat program methods 1990).

RESULTS AND DISCUSSION

Safe control methods:

Agricultural control methods

1- Tillage process:

Tillage process was carried out to investigate its effect in reducing *T. pisana* and *H. vestalis* population density.

Table(1): Effect of plowing process on population density of *Theba. pisana* and *Helicella. vestalis* infesting *C. nobilis* trees at newly salhyia, Sharkia Governorate.

Time (week)	Mean numbers of snails and reduction percentages					
	T. pisana			*H. vestalis*		
	Mean numbers		Reduction percentages	Mean numbers		Reduction percentages
	untreated area	plowing		untreated area	plowing	
1	15.6	5.3	66.0	13.1	4.2	67.9
2	16.7	6.2	62.8	16.2	7.1	56.1
3	18.4	7.3	60.3	17.2	9.3	45.9
4	20.5	10.4	49.3	19.3	11.4	40.9
5	21.7	11.6	46.5	20.4	13.2	35.3
6	22.9	15.3	33.1	21.2	15.5	26.9
General mean	19.3 A	9.35 B	53.0	17.9a	10.11b	45.5
F. test	**			**		
L.S.D 0.05	4.3342			4.6458		

Table (1) showed that tillage process reduced snails population with reduction percentages (66, 62.8, 60.3, 49.3, 46.5 and 33.1) of *T. pisana* and (67.9, 56.1, 45.9, 40.9, 35.3 and 26.9) of *H. vestalis*, after 1, 2, 3, 4, 5 and 6 weeks, respectively.

Statistical analysis showed that there is highly significant decreasing in the general mean number of the tested snails at plowing areas (9.35 and 10.11) in comparing with that untreated ones (19.3 and 17.9) for *T. pisana* and *H. vestalis,* respectively.

On the other hand, the general mean values of the reduction percentage revealed that plowing process reduced population density of *T. pisana* (53%) more than that of *H. vestalis* (45.5%).

These results are in agreement with that obtained by Woulters, (1970) who mentioned that, rough ploughing of the soil before sowing of winter wheat protected seeds from damage caused by land snails. El- Massry (1997) illustrated that the ploughing process decreased individuals of the land snail *H. vestalis* after one day post ploughing while, the highest reduction percentage after 15 days post ploughing was 91.6%..Moreover, Salem *et al.* (2007) reported that ploughing decreased the population of *M. cartusiana* and *E. vermiculata* land snail species. Finally, Shetaia (2010) revealed that ploughing and flattening process gave the highest reduction percentages recording 68.3 % and 41.35%, respectively.

2 - Plant trap (cabbage):

The effect of certain plant snares as planting cabbage on reducing population density of *T. pisana* and *H. vestalis* snails infesting *C. nobilis* trees was studied. Data in Table (2) revealed that cabbage snares obtained highly significant reduction in the general mean of the population density of both species recording 11.6 and 11.65 compared with that untreated ones 21.5 and 25.3 of *T. pisana* and *H. vestalis*, respectively before planting cabbage.

Table(2): Effect of plant trap (cabbage) on population density of *Theba. pisana* and *Helicella. Vestalis* infesting *C. nobilis* trees at newly salhyia, Sharkia Governorate.

Time (week)	Mean numbers of snails and reduction percentages					
	T. pisana			*H. vestalis*		
	Mean numbers		Reduction percentages	Mean numbers		Reduction percentages
	untreated area	Cabbage		untreated area	Cabbage	
1	18.4	15.2	17.4	21.4	15.2	28.9
2	20.2	13.9	31.1	23.6	14.3	39.4
3	21.2	11.7	44.8	25.1	11.6	53.8
4	22.7	10.2	55.0	25.4	10.3	59.4
5	22.9	9.6	58.0	27.2	9.8	63.9
6	23.7	9.1	61.6	29.3	8.7	70.6
General mean	21.5 A	11.6 B	44.7	25.3 a	11.65 b	52.7
F. test	**			**		
L.S.D 0.05	2.7144			3.4356		

The reduction percentages were (17.4, 31.1, 44.8, 55, 58, and 61.6 %) of *T. pisana* and (28.9, 39.4, 53.8, 59.4, 63.9 and 70.6%) of *H. vestalis* after 1, 2, 3, 4, 5 and 6 weeks, respectively. Regarding the general means of population reduction percentage were 44.7% and 52.7% for *T. pisana* and *H. vestalis*, respectively. These results are in harmony with those reported by many authors. Staikou *et al*. (1988) indicated that *Helix lucorum* fed on cabbage exhibited maximal assimilation authority than those fed on *Urtica dioica*. Ismail (1997 & 2004) revealed that leaves of lettuce and cabbage were the maximum superior aliment for *E. vermiculata* and *M*. *cartusiana* as compared to all plant leaves were tested. Kalifa (2009) recorded that leaves of sweet pea and cabbage were the maximum superior food for *M*. *cartusiana.*

Mechanical control method:

Hand Picking of land snails:

Hand picking as mechanical control method was evaluated in reducing population density of *T. pisana* and *H. vestalis* snails infesting on *Citrus nobilis* trees. Data in Table (3) showed that hand picking reduced population of both species where the mean number of snails was decreased after one week from 20.7 to 8.3 followed by 2, 3, 4, 5 and 6 weeks post treatment, the populations were decreased from (22.0, 23.2, 25.9, 26.4 and 27.0) to (12, 15, 18.9, 20 and 21) respectively, for *T. pisana* and were decreased from (17.2, 16.4, 14.2, 12.6, 11.6 and 10.2) to (5.6, 6.8, 8.4, 7.8, 7.6 and 6.9) respectively, for *H. vestalis*.

Table (3): Effect of land snails hand picking on population density of *Theba. pisana* and *Helicella. vestalis* infesting *C. nobilis* trees at newly salhyia, Sharkia Governorate.

Time (week) after tillage treatment	Mean numbers of snails and reduction percentages					
	T. pisana			*H. vestalis*		
	Untreated area	hand picking	Reduction percentages	Untreated area	hand picking	Reduction percentages
1	20.7	8.3	59.9	17.2	5.6	67.4
2	22.0	12.0	45.4	16.4	6.8	58.0
3	23.2	15.0	45.0	14.2	8.4	40.8
4	25.9	18.9	30.5	12.6	7.8	38.0
5	26.4	20.0	24.2	11.6	7.6	34.4
6	27.0	21.0	22.2	10.2	6.9	32.3
General mean	24.2 A	15.8 B	37.9	13.7a	7.2b	45.2
F. test	**			**		
L.S.D 0.05	5.1336			2.6498		

Regarding the reduction percentages post treatment the average values were 37.9 and 45.2 % for *T. pisana* and *H. vestalis* repectively. Statistical analysis cleared that there was highly significant decrease in the general mean values of snails number post treatment, 15.8 and 7.2 for *T. pisana* and *H. vestalis* respectively compared with 24.2 and 13.7 pro-treatment.

Hand picking method was evaluated for controlling land snails by many authors as Carman (1965), Bishara *et al.* (1968), Woulters (1970), Shah (1992), Tiller *et al.* (1995) Abd El- Aal (2001), Mahrous *et al*. (2002 a & b) El- Deeb *et al*. (2003) and Shetaia (2010) applied the hand collection as mechanical control method against *M. cartusiana* and *E. vermiculata*.

Non – safe control methods:

Data presented in Table (4) showed the reduction percentage values of *T. pisana* and *H. vestalis* exposed to six toxicants formulations in descending order with one concentration (2%) under citrus orchard conditions. The most effective one was glyphosate followed by carbofuran, chlorpyrifos - methyl, methamidophos, paraquate and xentari with average values of population reduction percentage 58.02, 50.1, 48.07, 44.4, 39.8 and 31.9 respectively of *T. pisana*. The corresponding values of *H. vestalis* were 61.4, 54.0, 49.2, 47.8, 42.6, 32.02.

Statistical analysis showed non-significant difference between the average values of the reduction percentages at the different tested pesticides.

The present results are in agreement with those obtained by Godan (1983) who reported that using herbicides not only kill weeds but also mollusks either through the animal skin or by the ingestion through the intestine. Hegab (1998) found that the organophosphates induced the highest effect when were evaluated under field conditions. Shetaia (2005) found that the bran toxic baits of five oxime carbamate pesticides resulted to highly toxic effect against *T. pisana*. The foregoing results about the biocide, *Bacillus thuringiensis* are in agreement with the findings of Godan (1983) who assured that some species of bacteria potentially attack snail in colony of

mass rearing. In India, Sharma and Agarwal (1989) controlled the snails with bacterial pathogen that cause a leucoderma – like disease showed that a microbial molluscicides can be useful when sprayed on the healthy snails. Zaki (1993) controlled black cutworm (*Agrotis yopsilon*) by using B.T.K. and had satisfactory results for protection of some plants. The same author, also controlled larvae of *Pairis rapae* on cabbage plants by B.T.K. and showed efficacy equal to insecticides lannate and gardona. Sharaby (1993) assured efficiency of B.T. against leafworm and black cutworm larvae by using the natural hosts with dipping technique under room conditions. In Italy Pasqualini (1987) used B.T.I. for the control of several species of Lepidoptera and Diptera. Ghamry (1997) assured that snail *Helicella sp w*as the highest susceptible by *B. thuringiensis* followed by snail *Monacha sp*., while snail *Eobania sp.*, was the lowest one.

Table(4): Population reduction percentages of *Theba. pisana* and *Helicella. vestalis* at concentration 2 % of the tested toxicants as poisonous baits in *C. nobilis* field at newly salhyia, Sharkia Governorate.

Pesticides	Reduction percentages									
	T. pisana					*H. vestalis*				
	1	7	15	21	Average	1	7	15	21	Average
Glyphosate	29.4	39.5	72.4	90.8	58.02	30.4	45.3	78.7	91.2	61.4
Carbofuran	24.3	36.3	69.2	70.6	50.1	30.6	37.7	65.3	82.4	54.0
Chlorpyrifos-methyl	21.9	33.4	56.3	80.7	48.07	20.5	36.5	67.5	72.3	49.2
Methamidophos	20.5	30.2	60.1	66.7	44.4	19.7	40.9	60.1	70.5	47.8
Paraquate	13.2	25.6	53.5	66.9	39.8	20.3	25.1	59.9	65.1	42.6
Xentari	10.7	35.1	40.9	40.8	31.9	15.8	15.1	45.7	516	32.02
F. test					N.S					N.S
L.S.D 0.05					35.1637					35.4352

According to the obtained results, it can be recommended by using safe methods at non- outbreak times of snails for keeping the environmental qualities away from pollution but toxicants must be used at outbreak times for preventing population density of the pest to reach the economic injury level followed by using safe (agricultural and mechanical) methods for managing the populations.

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المكافحة المتكاملة باستخدام طرق مختلفة لمكافحة القواقع الارضية ثبيا بيثانا و هليسيللا فستالس التى تصيب اشجار اليوسفى بمحافظة الشرقية

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استهدفت هذه الدراسة تقييم دور و كفاءة عدد من طرق المكافحة الآمنة وغير الآمنة كنموزج للمكافحة المتكاملة فى خفض الكثافة العددية لنوعين من القواقع الارضية وهما ثبيا بيثانا ، هليسيللا فستالس التى تصيب اشجار اليوسفى فى احد البساتين بمنطقة الصالحية الجديدة - محافظة الشرقية وذلك خلال عام 2010 – 2011.

وقد تمثلت المكافحة الآمنة فى :

1- المكافحة الزراعية ممثلة فى عمليتى الحرث والمصايد الزراعية مثل نبات الكرنب

2- المكافحة الميكانيكية ممثلة فى الجمع اليدوى للقواقع

اما المكافحة غير الأمنة فقد تمثلت فى استخدام بعض المبيدات الكيميائية والحيوية وهى: جليفوسات ، كاربوفيوران ، كلوربيريفوس ، ميثاميدوفوس ، باراكوت ، زنتارى وقد اوضحت النتائج ان كل عناصر المكافحة المتكاملة التى تم تقييمها ادت الى خفض تعداد كلا النوعين من القواقع . اظهرت المبيدات المستحدمة ان مبيد الحشائش (جليفوسات) كان اشد تاثيرا من باقى الطرق معطيا اعلى نسبة مئوية للخفض فى التعداد (58.02 ، 61.4) % يليه عملية حرث الارض (53، 45.5) % ، المصايد الزراعية **(44.7 ، 52.7)** % ، الجمع اليدوى (37.9 ، 45.2) % بينما كان المبيد الحيوى (زنتارى) اضعفها تاثيرا (31.9 ، 32.02) %. علاوة على ذلك كان الترتيب التنازلى لكفاءة المبيدات المختبرة والتى استخدمت كطعوم سامة هو: الجليفوسات (58.02 ، 61.4) % - الكاربوفيوران

(50.1 ، 54) % - الكلوربيريفــوس (48.07 ، 49.2) % - ميثاميــدوفوس (44.4 ، 47.8 % – بــاراكوت (39.8 ، 42.6) % – زنتــارى (31.9 ، 32.02) % وذلــك لقوقعى ثبيا بيثانا ، هليسيللا فستالس على التوالى .

فى ضوء النتائج الموضحة فانه يمكن التوصية بتطبيق طرق المكافحة الآمنة حال عدم تفشى اعداد القواقع للحفاظ على البيئة من التلوث بينما يجب استخدام المبيدات حال تفشى اعدادها لمنع وصول تعداد القواقع الى مستوى الضرر الاقتصادى يعقبها تطبيق الطرق الآمنة (الزراعية – الميكانيكية) لمكافحة التعداد المتبقى وذلك ضمن برامج المكافحة المتكاملة للأفة.

قام بتحكيم البحث

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