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Attractiveness and Toxic Effect of Testing Bait Treatments Against the Most Common Terrestrial Snails in Alexandria, Egypt

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ABSTRACT. Laboratory and field experiments were conducted to study the attractiveness and/or toxic effect of four testing bait preparations against *Eobania vermiculata, Theba pisana* and *Helicella vestalis* the most common terrestrial snail species. The testing baits were formulated by using preferable substances for the snails such as lettuce, cabbage and molasses. In addition, a trail was conducted to use crushed *T. pisana* snails as an attractive material. All the aforementioned materials were mixed with wheat bran and methomyl (Lannate) 1.5% w/w. Laboratory results, illustrate that, there were significant differences between treatments, whereas *E. vermiculata* snails exhibited the highest percentage of attraction (90%) to the testing baits based on molasses and cabbage, either prepared in fresh or stored at room temperature for 10 days. *T. pisana* snails exhibited the highest percentage of attraction (80%) for bait based on crushed *T. pisana* snails, while *H. vestalis* snails exhibited the lowest percentage values among all the testing bait preparations. Percent mortalities of the treated snail species show the same trend as result of percent attraction. Field results illustrate that, there were significant differences between different treatments. Whereas, the highest percent decrease rate of *T. pisana* snail number (85.20) was observed. Results also, indicate that, there were significant differences in the percent decrease of the mean number of *H. vestalis* snails. The highest mean values recorded were(8.31 and 7.69 snails/cotton plant in the case of testing bait based on molasses and cabbage, respectively. Baits based on cabbage, lettuce and molasses revealed, significant decreases in the percent of the mean numbers of *H. vestalis* snails, whereas 29.499%, 27.310% and 23.52 % of decreasing rates were exhibited, respectively.

Introduction

Terrestrial snail have been known to be destructive agricultural animal pests, especially in northern areas in Egypt. They are causing severe damage to many of different crops, vegetables, ornamentals and citrus trees, Kassab and Daoud (1964); El-Okda *et al.* (1989); El-Wakil and Radwan (1991); El-Wakil *et al.* (1992); Kassem and Abdallah (1992); Radwan *et al.* (1992); El-Wakil and Mesbah (1995); El-Wakil (1999); El-Wakil and Attia (1999).

Control of terrestrial snails is necessary to protect different crops, as well as decrease the economic loss. However different control measures were used for snail control such as physical, biological and chemical methods, Godan (1983). Molluscicides as well as other chemicals including carbamates, oxime carbamates, organophosphorous, inorganic metal compounds and inorganic fertilizers were used either as contact poisons or as toxic baits, Judge (1969); Godan (1983); Young and Wilkins (1989); Olkowski *et al.* (1991); Radwan and El-Wakil (1991); Bullock *et al.* (1992); Bradley and Runham (1996); Chen *et al.* (1996); Davis *et al.* (1998); Sakovich (1996); Triebskorn *et al.* (1996); Young (1996); Hata *et al.* (1997); Abdallah *et al.* (1998a); Abdallah *et al.* (1998b).

Toxic baits are considered to be one of the most effective measure against terrestrial snails especially those which contain attractive materials. The common baits which used in this respect were based on molasses formulated with wheat bran as attractive baits, El-Okda *et al.* (1983); Godan (1983); Johanston (1985); Henderson and Packer (1986); El-Wakil and Radwan (1991); Radwan and El-Wakil (1991); El-Wakil *et al.* (1992); Radwan *et al.* (1992) and El-Wakil and Attia (1999).

In the current study, laboratory and field experiments were conducted to evaluate the attractiveness and/or toxic effect of four testing bait preparations against the most common terrestrial snail species in Alexandria, Egypt. These snail species were recorded for the first time infesting cotton crop. Preferable substances for the snails such as lettuce, cabbage and molasses were used in the testing bait formulations. In addition, crushed *Theba pisana* (Müller) snails mixed with wheat bran as an attractive material. All the aforementioned materials were mixed with wheat bran and methomyl (Lannate) 1.5 % w/w.

Materials and Methods

Animals

Brown garden snail *Eobania vermiculata* (Müller), white garden snail *Theba pisana* (Müller) and *Helicella vestalis* (Müller) snails were used as experimental animals in this study.

Plants

Cotton crop (vertoon cotton) cultivated in the farm of Alexandria University at El-Sobahia region, infested with *Theba pisana* (Müller) and *Helicella vestalis* (Müller) snails.

Tested Pesticide

Methomyl (Lannate)® 90% SP, "S-methyl N (methyl carbamoyl oxy) thioacetamidate". A concentration of 1.5% w/w of the tested pesticide was used.

Testing Bait Preparations

Four testing baits were prepared based on a concentration of 1.5% methomyl (Lannate)® as follows:

1. The first bait consists of molasses and wheat bran in the ratio of 5:93.5 w/w respectively.
2. The second bait consists of crushed *Theba pisana* snails and wheat bran in the ratio of 5:93.5 w/w respectively.
3. The third bait consists of minced lettuce and wheat bran in the ratio of 5:93.5 w/w respectively.
4. The fourth bait consists of minced cabbage and wheat bran in the ratio of 5:93.5 w/w respectively.

Each of the aforementioned testing baits are prepared in three different forms: were submitted for (a) in the fresh form, (b) as baits stored at room temperature for 10 days and (c) as baits stored under refrigerator conditions for 10 days. In the field experiments testing baits are prepared in fresh form only.

Experiments

I: Laboratory Studies

Adult snails of *Eobania vermiculata, Theba pisana* and *Helicella vestalis* were collected from El-Sobahia region and allowed to acclimatize under laboratory conditions for at least 2 weeks and were fed on bran bait *ad libitum.* Healthy and active snails were chosen for this studies.

Nine glass containers were divided into three groups (Group 1, Group II, and Group III). Each group had 3 glass containers and each container had four petry dishes distributed on its four corners. Each of the aforementioned testing baits was placed in petry dish and 10 individuals of the snail species were placed in the middle of the containers. Then the containers were covered by secured muslin to prevent the snails from escaping. Containers were checked daily and the

percentage of the attracted snail numbers and also the percentage of snail mortalities were calculated. Group I was used for the fresh testing baits and Group II was used for the testing baits which stored at room temperature for 10 days. Group III was used for the testing baits which stored under refrigerator conditions for 10 days.

II: Field Studies

The testing baits (Group I in fresh form) were used against the two common terrestrial *Theba pisana* and *Helicella vestalis* snails infesting cotton crop as follows:

1. The field cultivated with cotton crop was divided into several plots. Each plot include 20 lines and each line had 5 cotton plants.
2. Three plots were chosen randomly. Every plot was divided into four groups and each group consisted of 5 lines (Total of 20 lines/ plot).

The mean number of the snails per cotton plant was calculated before treatment (zero time). Then each five lines were treated with one of the aforementioned testing baits, whereas each bait was placed surrounding the base of each cotton tree. After one, three and five weeks post treatments, the decrease in the mean number of the infested snails per tree and the percentage rate decreases of the snail numbers were calculated.

Statistical Analysis

Statistical analysis for the obtained data were made by using General Linear Model procedure (GLM) and Least Significant Difference (L.S.D) at 0.05 as a level of significance, SAS (1987).

Results and Discussion

I: Laboratory Studies

Results of the laboratory studies are illustrated in Tables (1and 2). Results in Table (1) showed the percentage of the mean number of the snails attracted to the testing baits. It was clear that, there are significant differences at ($P<0.01$) between the percentage of the mean number of the treated snails with different testing baits. Moreover, there were significant difference at ($P<0.01$) between different snail species treated with different type of the testing bait preparations.

Eobania vermiculata snails exhibited the highest percentage of attraction (90%) to the testing baits based on molasses which is prepared either fresh or stored at room temperature for 10 days.

Testing bait based on cabbage prepared in the fresh form exhibited 60% attraction for *E. vermiculata* snails. It also exhibited 60% attraction for the same

TABLE 1. % Attractiveness of terrestrial snails treated with testing baits based on the methomyl (Lannate 1.5 % w/w).

Testing bait preparations	% Mean of snail numbers attracted to the testing bait preparations												Total mean of % attraction of snail numbers
	Molasses			Crushed *T. pisana* snails			Lettuce			Cabbage			
	Eobania vermiculata	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	
Fresh	90	60	20	20	80	0.0	50	70	10	90	60	30	48.33^{a}
Stored at * room temperature	90	50	50	60	20	20	40	10	20	60	60	50	44.16^{a}
Stored at ** refrigeration conditions	60	40	30	40	40	20	50	20	10	60	20	20	34.16^{b}
Total mean (%)	80^{a}	50^{c}	33.33^{e}	40^{d}	46.66^{c}	13.33^{f}	46.66^{k}	33.33^{e}	13.33^{f}	70^{b}	46.66^{c}	33.33^{e}	42.222

Mean in a column not sharing the same superscript are significantly different at ($P < 0.01$).
* Baits stored at room temperature for 10 days.
** Baits stored at refrigeration conditions for 10 days.
$L.S.D_{(0.05)}$ (Between species) = 7.302.
$L.S.D_{(0.05)}$ (Between testing bait preparation) = 8.43.
$L.S.D_{(0.05)}$ (Between testing bait) = 7.302.

snail species either when it was stored at room temperature or when it was stored under refrigeration condition for 10 days. Snails treated with bait based on crushed *T. pisana* snails exhibited the highest percentage of attraction (80%) for *T. pisana snails,* while *H. vestalis* snails exhibited the lowest percentage value among all the testing bait preparations.

T. pisana snails treated with the testing bait based on lettuce which was prepared in the fresh form exhibited the highest percentage of attraction (70%), while *H. vestalis* snails showed the lowest percentage value among different type of bait preparations. Also, it exhibited 50% of attraction in the case of *E. vermiculata* snails either in case of fresh preparation or in case of bait stored under refrigeration conditions for 10 days. The results also showed that, fresh bait based on cabbage exhibited 90% attraction for *E. vermiculata* snails, while the lowest value (20%) of attraction was shown in the case of *H. vestalis* snails which was treated with bait stored under refrigerator conditions for 10 days.

In general, testing baits prepared in the fresh form exhibited the highest average of % attraction of the treated snail species (48.33%). While in the case of testing bait stored either at room temperature or under refrigeration conditions exhibited 44.16% and 34.16% of attraction of treated snails species, respectively. It is worth mentioning that, testing baits based on cabbage came in the first order for its attractiveness for treated snail species, followed by testing baits based on molasses and at the last that bait based on crushed *T. pisana* snails.

Table (2) illustrates the percentage mortality among snail species attracted to the different testing baits. However, the obtained results indicate that, there are significant differences at ($P<0.01$) between different type of bait preparations and also between testing bait treatments.

Results indicate that, the highest percentage mortalities were 60%, 70 and 60% for *E. vermiculata* snails treated with the testing baits based on molasses prepared in fresh form and the testing baits stored at room temperature for 10 days and the baits which stored under refrigeration conditions for 10 days respectively. Fresh testing molasses bait also showed 60% mortality in the case of *T. pisana* snails. The lowest percentage mortalities resulted in the case of *H. vestalis* snails.

In the case of the treatment with testing bait based on crushed *T. pisana* snails, the highest percentage of mortality (80%) was exhibited in the case of *T. pisana* snails treated with the bait prepared in fresh form. While the lowest percentage of mortality values were exhibited in the case of *H. vestalis* snail. It was clear that *T. pisana* snails were attracted to the bait more than the others and that may be because of some substances released from the crushed *T. pisana*

TABLE 2. % Mortality of terrestrial snails treated with testing baits based on the methomyl (Lannate 1.5% w/w).

Testing bait preparations	% Mortality of treated snail species.												Total mean of % attraction of snail numbers
	Molasses			Crushed *T. pisana* snails			Lettuce			Cabbage			
	Eobania vermiculata	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	*Eobania vermiculata*	*Theba pisana*	*Helicella vestalis*	
Fresh	60	60	0.0	10	80	0.0	30	40	10	50	50	30	35^{a}
Stored at * room temperature	70	40	30	30	10	10	30	10	20	50	50	30	31.66^{a}
Stored at ** refrigeration conditions	60	20	0.0	30	10	20	40	20	0.0	45	20	10	22.92^{b}
Total mean (%)	63.33^{a}	44^{c}	10^{f}	23.33^{e}	33.33^{d}	10^{f}	33.33^{d}	23.33^{e}	10^{f}	48.33^{b}	40^{c}	23.33^{e}	29.86

Mean in a column not sharing the same superscript are significantly different at ($P < 0.01$).
* Baits stored at room temperature for 10 days.
** Baits stored at refrigeration conditions for 10 days.
$L.S.D_{(0.05)}$ (Between species) = 5.731.
$L.S.D_{(0.05)}$ (Between testing bait preparation) = 6.618.
$L.S.D_{(0.05)}$ (Between testing bait) = 5.731.

snails, which may play a role in *T. pisana* snails attraction. This may explain the increase of the percentage mortality for *T. pisana* snails more than the other species. On the other hand, testing baits based on lettuce gave the highest average of the percentage mortalities in the case of *E. vermiculata* snails followed by *T. pisana* snails, while the lowest effect was shown in the case of *H. vertalis* among the different type of bait preparations.

In the case of toxic bait based on cabbage, *E. vermiculata* snails exhibited the highest average of percentage mortality (48.33%) followed by *T. pisana* snails (40%) while *H. vestalis* snails showed the lowest percentage mortality (23.33%). Generally the highest percentage mortalities were shown in the case of snail species treated with the fresh prepared baits, while the lowest percentage of mortalities were shown in the case of the snails treated with baits stored under refrigeration conditions for 10 days. Also, testing baits based on molasses came in the first order in their effect followed by that testing baits which based on cabbage. This may be due to the effect of fermentation effect for molasses and some volatile substances in cabbage which play the main role in the attraction of the snail species, Godan (1983) and Henderson and Packer (1986).

From the results presented in Table (1) and Table (2) it is clear that, not all the bait formulations attracted snail species by the same degree, but every snail species has its favorite baits. In the present study *T. pisana* snails prefer baits based on crushed *T. pisana* snails more than the other baits. On the other hand, some snail species, prefer baits stored at room temperature more than the fresh baits and vice versa.

The obtained results indicate that, the efficacy of methomyl (Lannate) was affected by both the type of testing bait preparations and also by the attractive materials which the baits are based on. Lannate has repellent effect against terrestrial snails, Godan (1983). According to the present results of this study, Lannate could be effective against terrestrial snails when used with such aforementioned attractive materials.

II: Field Studies

Results of the field application of the testing baits as shown in Table (3) revealed that, there were significant differences at ($P<0.01$) between different testing bait treatments and between treated *T. pisana* snails and between different time intervals post treatments.

Table (3) illustrates the effect of different testing bait treatments on the mean number of *T. pisana* snails among different time intervals post treatments and on the decreasing percent rate of the snail numbers per tree, whereas there were

significant decrease in the mean numbers of the snails as compared with the control group. Also, there were significant differences between total means of snail numbers treated with different testing bait treatments among different exposure periods. However, the highest decrease rate of the snail numbers (85.203%) was observed at the end of the experiments in the case of snail treated with testing baits based on crushed *T. pisana* snails. These results agree with the aforementioned laboratory results in this study, whereas the highest percent attraction of snails was observed for *T. pisana* snails treated with the same testing bait. The other testing baits exhibited significant decrease in the snail numbers as compared with the control group.

TABLE 3. Effect of testing bait treatments based on methomyl (Lannate 1.5% w/w) on the mean numbers of *Theba pisana* snails infesting cotton crop during 5 weeks post treatments.

Time intervals post treatments (weeks)	Mean number of snails / plant.					Total Mean ± S.D
	Control (Mean ± S.D) (%)	Molasses (Mean ± S.D) (%)	Crushed *T. pisana* (Mean ± S.D) (%)	Lettuce (Mean ± S.D) (%)	Cabbage (Mean ± S.D) (%)	
0	10.64 ± 0.11	7.49 ± 0.64	8.38 ± 0.39	8.22 ± 0.59	8.73 ± 0.73	a 8.693 ± 0.49
1	11.44 ± 0.03 (0.00)	4.33 ± 0.56 (42.189)	3.40 ± 0.36 (59.427)	4.91 ± 0.39 (40.268)	5.80 ± 0.64 (33.562)	b 5.978 ± 0.66 (31.232)
3	11.71 ± 0.08 (0.0)	3.13 ± 0.42 (58.211)	3.20 ± 0.27 (61.814)	3.47 ± 0.43 (57.786)	3.71 ± 0.28 (57.503)	bc 5.045 ± 0.69 (41.965)
5	12.24 ± 0.05 (0.0)	1.78 ± 0.44 (76.235)	1.24 ± 0.16 (85.203)	1.40 ± 0.20 (82.968)	1.65 ± 0.18 (81.099)	c 3.663 ± 0.92 (57.863)
Total Mean ± S.D	a 11.510 ± 0.11 (0.0)	b 4.183 ± 0.66 (58.878)	b 4.056 ± 0.67 (68.815)	b 4.501 ± 0.69 (60.341)	b 4.973 ± 0.73 (57.388)	5.845

Mean in a column not sharing the same superscript are significantly different at ($P < 0.01$).
Values between brackets = % decreasing rate in snail numbers.
$L.S.D_{(0.05)}$ (Time intervals) = 0.299.
$L.S.D_{(0.05)}$ (Treatments) = 0.334.

Results presented in Table (4) illustrate the effect of different testing bait treatments on the mean number of *H. vestalis* snails at different time intervals post treatments. Whereas, the results indicate that, there were significant decrease in the mean numbers of snails among the different treatments and between different time intervals post treatments as compared with the control

group. The lowest decrease in the mean number of the treated snails (7.53) per plant was observed in the case of testing bait based on lettuce. On the other hand the highest mean values were 8.31 and 7.69 in the case of testing baits based on molasses and cabbage, respectively. Bait based on crushed *T. pisana* snail has no significant effect on the *H. vestalis* snails, while baits based on cabbage, lettuce and molasses revealed significant decreases in the percentage of the mean number of snails as compared with control group. Whereas 29.499%, 27.310% and 23.521% of decreasing rate in snail numbers were exhibited, respectively.

TABLE 4. Effect of testing bait treatments based on methomyl (Lannate 1.5% w/w) on the mean numbers of *Helicella vestalis* snails infesting cotton crop during 5 weeks post treatments.

Time intervals post treatments (weeks)	Mean number of snails / plant.					Total Mean ± S.D
	Control (Mean ± S.D) (%)	Molasses (Mean ± S.D) (%)	Crushed *T. pisana* (Mean ± S.D) (%)	Lettuce (Mean ± S.D) (%)	Cabbage (Mean ± S.D) (%)	
0	12.62 ± 0.04	13.35 ± 0.18	14.89 ± 0.44	12.95 ± 0.24	13.98 ± 0.39	a 13.560 ± 0.27
1	13.22 ± 0.29 (0.00)	11.85 ± 0.15 11.236)	14.18 ± 0.44 (5.007)	11.24 ± 0.23 (13.205)	12.11 ± 0.38 (13.463)	b 12.521 ± 0.28 (7.662)
3	14.23 ± 0.07 (0.0)	10.47 ± 0.16 (21.573)	13.31 ± 0.38 (10.611)	9.47 ± 0.26 (26.873)	9.78 ± 0.40 (30.043)	bc 11.451 ± 0.38 (15.553)
5	14.65 ± 0.05 (0.0)	8.31 ± 0.12 (37.753)	12.44 ± 0.34 (16.454)	7.53 ± 0.36 (41.853)	7.69 ± 0.52 (44.993)	c 10.125 ± 0.53 (25.332)
Total Mean ± S.D	a 13.681 ± 0.12 (0.0)	b 10.995 ± 0.32 (23.521)	b 13.705 ± 0.36 (10.691)	b 10.300 ± 041 (27.310)	b 10.890 ± 0.52 (29.499)	11.914

Mean in a column not sharing the same superscript are significantly different at ($P < 0.01$).
Values between brackets = % decreasing rate in snail numbers.
$L.S.D_{(0.05)}$ (Time intervals) = 0.2206.
$L.S.D_{(0.05)}$ (Treatments) = 0.2467.

Results also indicate that, there was significant decrease in the mean numbers and percentages of the decrease rate of the snails among different time intervals post treatments. Whereas the lowest mean number of snails was 10.125 per tree with the highest rate of percent decrease in snail numbers (25.332%). This results agree with the results obtained in the aforementioned laboratory studies. *T.*

pisana snails were more affected by the testing baits especially that testing bait based on crushed *T. pisana* snails more than *H. vestalis* snails.

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الجاذبيـة والتأثيـر السـام للطعـوم المختبـرة ضـد أكثـر أنـواع القواقـع الأرضيـة شيـوعًا بالإسكندرية ، مصر

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مركز البحوث الزراعية ، الإسكنـدريـة – مصـر

المستـخلص . في هذه الدراسـة تم عـمل دراسات معـملية وحقلية لدراسـة الجـاذبيـة والسـمـية لأربعـة طعـوم مـحـضـرة ضـد *الإيوبانيا فيرميكيولاتا* و *الثيبابيسانا* و *الهيليسيلا فيستاليس* أكثر أنواع القواقع الأرضية شيوعًا . والطعوم المختبرة تم تجهيزها باستخدام مواد مفضلة للقـواقع مـثال الخس والكرنب ودبس السكر . أيضًـا تم عـمل مـحـاولة لاستخدام قواقع الثيبابيسانا المهشمة كمادة جاذبية . جميع المواد المنوه عنها سابقًا تم خلطها مع ردة القمح والميثوميل (الأنيت) بتركيز ٠,١٥٪ وزن/ وزن . النتائج المعملية أوضحت أن هناك فروقًا معنوية بين مختلف المعـاملات حيث إن قـواقع *الأيوبانيا فـيرميكيـولاتا* سـجلت أعلى نسـبة انجذاب (٩٠٪) للطعوم المجهزة من دبس السكر والكرنب سواء المحضرة في صـورة طازجة أو تلك المخزنة على درجة حـرارة الغرفـة لمدة ١٠ أيام . سجلـت قواقع *الثيبابيسانا* أعلى نسبة انجذاب (٨٠٪) للطعم المجـهز من قواقع *الثيبابيسانا* المهشـمة كما سـجلت قواقع *الهيليسيلا فيستاليس* أقل نسبـة انجذاب للـطعوم المختبـرة . أظهـرت النتائـج المتعلـقة بالنسـبة المئوية للموت لأنواع القواقع المعـاملة نفس الاتجاه في النتائج المتحصل عليها في النسبة المئوية الحقلية لانجذاب القواقع .

أظـهرت النتائج الحقلية أن هناك فروقا معنوية بين مختلف المعاملات . حيث بلغ أعلى نسبة مئوية في معدل انخفـاض عدد قـواقع *الثيبابيسانا* (٢٠,٨٥) . وأوضـحت النتائج أيضًـا أن هنـاك فـروقًـا معـنوية في النسـبة المئوية لانخفـاض متوسط أعداد قـواقع *الهيلسيلا فيستاليس* ، حيث بلغ أعلى قيـمـة لهـا (٨,٣١ و ٧,٦٩ قـوقع لكل شـجـرة) في حـالة الطعـوم

المختبرة المجهزة من كل من دبس السكر والكرنب على التوالي . الطعوم المجهزة من الكرنب والخس ودبس السكر أعطت انخفاضات معنوية في النسبة المئوية لمتوسط أعداد قواقع *هيليسيلا فيستاليس*، حيث بلغ معدلات الانخفاض ٢٩,٤٩٩٪ و ٢٧,٣١٠٪ و ٢٣,٥٢٪ على التوالي .