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THE RELATIVE SUSCEPTIBILITY OF FRUIT TREE SPECIES TO LAND SNAIL INFESTATION AS INDICATED BY CELLS IN THEIR EXCREMENT

A.W. TADROS, J.M. NAKHLA AND M.A. RIZK

Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

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Abstract

The land snail species *Theba pisana, Eobania vermiculata, Helicella vestalis* and *Cochlicella acuta* (Helicidae: Pulmonata) are serious pests in fruit orchards at Behera Governorate. The relative susceptibility of five fruit species (apple, orange, pear, plum trees and banana plants) to the four land snail species infestation was studied under laboratory conditions, during 1998 by identification of fruit leaf cells in their excrement. Results indicated that *T. pisana, H. vestalis* and *C. acuta* highly prefer pear, while *E.vermiculata* prefers banana. Oranges ranks second in their favourability. On the contrary, plum and apple are not preferred for the snail species, beside banana for *C. acuta.* Moreover, pear and orange are mostly attacked by *T. pisana* and banana by *E.vermiculata.*

INTRODUCTION

Because of their highly nutritive values, fruit trees are subjected to land snail infestation in orchards, especially in the northern regions of Egypt (Kassab & Daoud, 1964; Bishara *et al.*, 1968, El-Okda, 1981; Hashem *et al.,* 1992 & 1993; Nakhla *et al.,* 1993a & 1993b; Nakhla and Tadros, 1993).

Nakhla *et al.* (1995) determined the food preference of some land snails to different vegetative matters in an orange orchard (orange, banana and 18 weed species).

Ferriere (1976, 1977, 1979 and 1980) successfully developed "Microscopic Examination Techniques (M.E.T.)" of gut contents of the earthworms. The present study is an attempt to utilize these methods of microscopic examination of plant cells in food and faeces for four species of land snails through samples of apple, orange, pear, plum and banana leaves brought from Behera Governorate during 1998 to determine the food preference of these snail species.

MATERIALS AND METHODS

Land snails in five fruit orchards (apple, banana, orange, pear and plum) located at Kafr El-Dawar, Behera Governorate were recorded. Starting from early April 1998,

regular samples of 100 individuals of each snail species of almost the same size were brought from each fruit orchard to the laboratory at Plant Protection Research Institute at Dokki, Giza Governorate.

To eliminate food bias, snails were reared on lettuce leaves for one month. During early May 1998, samples of random aged leaves of each fruit species were brought to the laboratory and were offered to each snail species.

Batches (100 individuals) of each snail species (20 individuals x 5 replicates) were confined in plastic containers (15 cm high x 30 cm diam.) covered with a plastic pored dish and kept under mean laboratory conditions of 26.3°C and 65.4% R.H. without food for 24 hours to get rid of all faeces containing lettuce cells.

During 10 successive days, a combination of sufficient leaves of the five fruit species (20 leaves of each fruit species) were offered to each replicate.

Slides of faeces of each replicate were prepared at 2 day intervals for 10 successive days, examined for plant cells and classified according to their fruit species cells. Slides of each fruit species cells and setae were prepared for identification and to serve as key slides.

The "Microscopic Examination Technique" developed by Ferriere (Op.cit.) (1980) was used to prepare and examine plant cells used as food by snails as well as the faeces collected from them. The number of epithelial plant cells in the snail faeces which related to the plant cells prepared from the food plants were counted. The clearing of the botanical material consisted of the following steps:

1. Fresh fruit plant leaves

1.1. Samples were taken from the leaves of the fruit trees.
1.2. The samples were placed in a mixture of alcohol and glycerin (95: 5) for 4-5 h to soften the cell walls.
1.3. Samples were then crushed by a hard object (blunt end of a jar rod) to help penetration of chemicals.
1.4. Javelle water of 18°C strength (sodium hypochlorite) was added to the samples for decolouration.
1.5. Samples were left 4-5 h for process completion.
1.6. Drops of formalin: water (1: 9) were added until the javelle crystals were removed.
1.7. Few plant cells were mounted on the slide, covered and microscopically examined.

2. Faeces

2.1. One pellet of faeces placed on a slide and covered by drops of the alcohol/glycerin mixture (95 : 5) for 5 h.

2.2. Samples were crushed with a hard object mentioned before.

2.3. Javelle solution was added and the slide was left 4-5 h.

2.4. Formalin: water drops (1: 9) were added to remove the javelle crystals.

2.5. The slide was covered and examined.

Cells of each specific plant appeared in each slide of each snail faeces were counted and presented in tables 1 and 2 as relative importance value (R.I.V.) for each cell type, based on the formula suggested by Beals (1960):

I.V. = $DF^{1/2}$ where,

D = Density (no. of cell type "a"/no. of pellets examined).

$$F = \frac{\text{(Frequency (no.of occurrences of cell type "a")}}{\text{(no.of occurrences of all cell types)}} \times 100$$

The resulting I.V. can either be logged or transformed into a relative importance value (R.I.V.), where:

$$\text{R.I.V. of cell type "a"} = \frac{\text{I.V. of cell type "a"}}{\text{Sum of I.V.of all types}} \times 100$$

Analysis of variance "F" and the Least Significant Differences "L.S.D." were used for the differentiation between the mean numbers of plant cells used as food for land snails (Snedecor & Cochran, 1956).

RESULTS AND DISCUSSION

The most common snail species recorded in apple, pear, plum, orange and banana orchards at Kafr El-Dawar, Behera Governorate are the small garden snail, *Theba pisana* (Muller), the brown garden snail, *Eobania vermiculata* (Muller), the small sand snail, *Helicella vestalis* (Pfeiffer) and the small tower snail, *Cochlicella acuta* (Muller).

The prepared slides of cells and setae of each specific fruit species are illustrated in Fig. 1. Identification of cells and setae of each fruit species was based on Metcalf & Chalk, 1950; Greiss, 1957; Boulos *et al.*, 1967.

1. Relative susceptibility of fruit species to each snail

1.1. *Theba pisana* (Muller): Data in Table 1 indicate that pear trees are the most favourable host to *T. pisana,* where R.I.V. is 32.4% followed by orange trees (R.I.V. = 24.5%) with no significant difference. Banana plants are moderately liable to the snail infestation than the previous two fruit species.

Significant difference was obtained as R.I.V. was 10.3%. Apple and plum trees are significantly less favourable to the snail feeding than the other fruit species showing R.I.V. of 2.4 and 1.7%, respectively. Xylem and unknown cells resulted in 18.3 and 10.6% R.I.V., respectively.

1.2. *Eobania vermiculata* (Muller): Table 1 further indicates that banana plants are significantly the most favourable host to the snail (R.I.V. = 47.2%). Orange, pear and apple trees are moderately favourable to the snail with significant differences between them and banana plants (R.I.V. = 12.7, 8.4 and 4.7%, respectively). Plum trees are significantly less favourable, the R.I.V. recorded was 1.3%. The R.I.V. of the xylem and unknown cells reached 20.8 and 4.9%, respectively.

1.3. *Helicella vestalis* (Pfeiffer): H. vestalis significantly prefers pear trees than other hosts (R.I.V. = 31.5%). Orange trees significantly ranked second showing R.I.V. of 17.8%, Table 1. Both of those fruit species are significantly more preferable as food than banana plants and apple trees (R.I.V. = 8.5 and 4.6%, respectively). Plum trees are the least preferable host showing a R.I.V. of 1.4%. Xylem and unknown cells are noticed in the snail faeces at R.I.V. of 24.1 and 12.1%, respectively.

1.4. *Cochlicella acuta* (Muller): *C. acuta* significantly prefers pear trees (R.I.V. = 30.8%), followed by orange trees (R.I.V. = 16.3%), then apple trees also without significant differences (R.I.V. = 14.0%). Plum trees and banana plants are significant less favourable than pear trees (R.I.V. = 2.6 and 2.4%, respectively). The R.I.V. of unknown and xylem cells are 23.5 and 10.5%, respectively.

2. Relative susceptibility of snail to each fruit species

2.1. Pear trees: Pear trees is significantly the most favourable host to *T. pisana* where the R.I.V. is 53.6 %, followed by *H. vestalis* (R.I.V. = 25.6%), Table 2. *C. acuta* and *E. vermiculata* significantly ranked third in their attack to pear trees, that R.I.V. recorded 12.0 and 8.7%, respectively.

2.2. Orange trees: As in pear trees, Table 2, *T. pisana* significantly attack orange trees (R.I.V. = 54.5%). *H. vestalis* and *E. vermiculata* significantly moderately prefer orange trees (R.I.V. = 19.4 and 17.5%, respectively). Statistical analysis also indicates the least degree of C. acuta infestation to orange trees (R.I.V. = 8.6%).

2.3. Banana plants: Table 2 clarifies that *E. vermiculata* is significantly the most abundant snail species on banana plant where R.I.V. is 66.4%. *T.pisana* dramatically and significantly decreased in their R.I.V. than the previous species (R.I.V. = 23.0%), followed by sharp significantly decrease for *H. vestalis* then *C.acuta* (R.I.V. = 9.4 and 1.2%, respectively).

2.4. Apple trees: As shown in Table 2, no significant differences are noticed between the four snail species in their degree of attack to apple trees. The R.I.V. of snail species preference to apple trees was 30.1, 27.2, 21.8 and 20.9% for *C. acuta, E. vermiculata, T.pisana* and *H. vestalis,* respectively.

2.5. Plum trees: As in apple, plum trees showed insignificant difference in its attraction to the four snail species although the R.I.V. of *T.pisana, H. vestalis, E. vermiculata* and *C. acuta* resulted in 43.1, 21.7, 20.0 and 15.2%, respectively, Table 2. This may be due to the general low numbers of each snail species attacking plum trees (6.0, 3.8, 3.6 and 3.0 individuals, respectively).

2.6. Xylem and unknown cells: *T.pisana* significantly showed the maximum consumption of xylem cells (R.I.V. = 40%), followed by *E. vermiculata, H. vestalis* (R.I.V. = 28.6 and 26.0%, respectively), then the least consumption by *C. acuta,* (R.I.V. = 5.4%), Table 2. The same table resulted in insignificant differences in consuming the unknown cells for *T. pisana, H. vestalis, C. acuta* and *E. vermiculata* although the R.I.V. is 42.1, 23.6, 22.1 and 12.3%, respectively. Also, this may be due to the relatively low numbers of cells found in their excrements.

Generally speaking, it can be concluded that pear trees is the preferred host for *T.pisana, H. vestalis* and *C. acuta,* while *E. vermiculata* preferred banana plants. Nakhla *et al.* (1993) also found that the host preference of *E. vermiculata* is banana plants.

Orange trees ranked second in their preference to the four snail species. On the contrary, plum and apple trees are not the prefered host to the three snail species, *T. pisana, E. vermiculata* and *H. vestalis* and plum trees and banana plants to *C. acuta.*

Moreover, among the four snail species, pear and orange trees are mostly attacked by *T.pisana*, banana plants by *E. vermiculata*. Pear, orange trees and banana plants are the least prefered hosts to *E. vermiculata, C. acuta and H. vestalis*, respectively. Apple and plum trees showed least susceptibility to the four snail species.

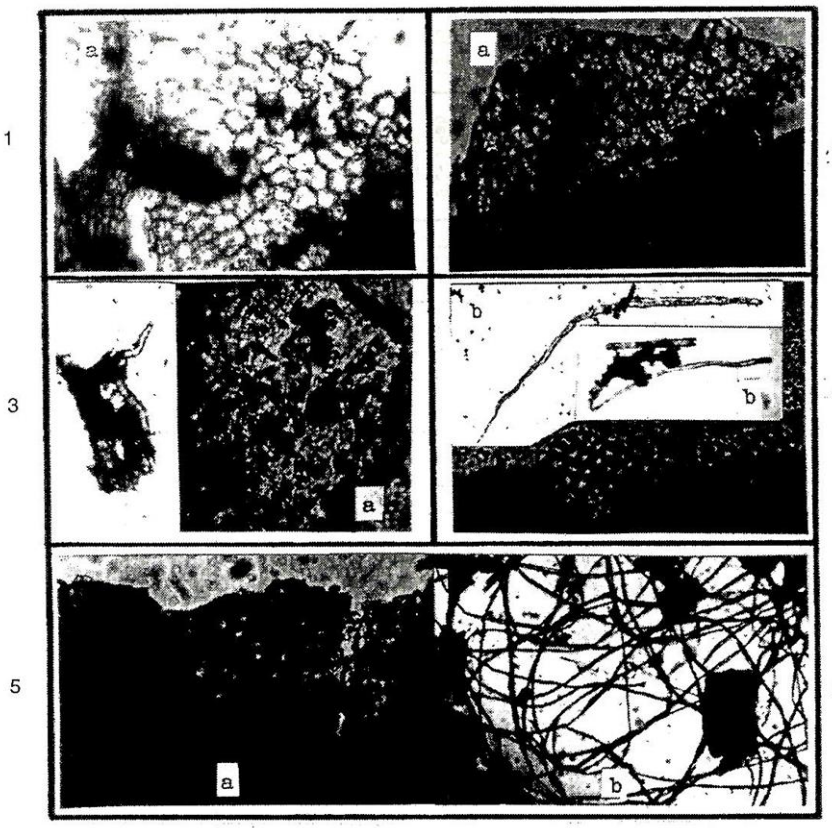

Fig. 1: Plant cells (a) and seta (b) of Apple (1), Pear (2), Pulm (3), Orange (4) and Banana (5).

Table 1. Mean numbers and relative importance values (R.I.V) of plant cells of each fruit species found in faecal pellets of *T.pisana, E.vermiculata, H.vestalis* and *C. acuta.*

Fruit species	*T. pisana*		*E. vermiculata*		*H. vestalis*		*C.acuta*	
	Mean	R.I.V. %	Mean	R.I.V. %	Mean	R.I.V. %	Mean	R.I.V. %
Pear *(Pyrus communis L.)*	42.2±3,4 a (30-48)	32.37	12.6±0.9 b (10-15)	8.41	25.8±4.2a (18-37)	31.51	15.6±1.5a (12-20)	30.84
Orange *(Citrus sinensis L.)*	35.0±3.2a (25-41)	24.46	16.4±1.6b (11-20)	12.69	17.6±1.7b (14-23)	17.75	10.2±2.0 ab (5-15)	16.30
Banana *(Musa sp.)*	19.6±2.8b -13.27	10.25	39.8±3.0a (30-47)	47.22	10.8±1.5c (7-15)	8.53	2.8±0.7b (1-5)	2.35
Apple *(Pyrus malus L.)*	7.4±1,4c (3.11)	2.38	8.6±1.4 bc (5-13)	4.74	7.0±1.3cd (4-11)	4.64	9.0±0.9ab (7-12)	13.96
Plum *(Prunus domestica L.)*	6.0±1.6c (3-11)	1.73	3.6±0.8c (1-5)	1.28	3.8±1.0cd (2-7)	1.38	3.0±0.7b (1-5)	2.60
Xylem cells	28.8±4.1 (19-40)	18.25	23.0±3.8 (12-33)	20.75	21.6±2.3 (17.30)	24.13	7.6±1.5 (4-12)	10.49
Unknown cells	20.0±1.5 (17-25)	10.56	8.8±1.4 (5-13)	4.91	13.6±1.8 (10-20)	12.06	13.0±2.6 (10-23	23.46
General total	159.0	100	112.8	100	100.4	100	61.4	100
"F"	39.4**		66.1 **		15.3**		20.5**	
L.S.D.	7.6		5.1		6.6		7.5	

L.S.D = Least significant differences
Same letters do not significantly differ.

Table 2. Average numbers and relative importance values (R.I.V) of plant cells of each fruit species found in faecal pellets of *T.pisana, E.vermiculata, H.vestalis* and *C. acuta.*

Fruit species	*T. pisana*		*E. vermiculata*		*H. vestalis*		*C.acuta*		General Total		F	L.S.D
	Av. No	R.I.V. %	Av. No	R.I.V. %	Av. No	R.I.V. %	Av. No	R.I.V. %	Av. No	R.I.V. %		
Pear *(Pyrus communis L.)*	42.2 a	53.60	12.6c	8.74	25.8b	25.62	15.6c	12.04	96.2	100	15.6**	8.8
Orange *(Citrus sinensis L.)*	35.0a	54.51	16.4b	17.48	17.6b	19.43	10.2c	8.58	79.2	100	17.2 **	6.6
Banana *(Musa sp.)*	19.6b	22.95	39.8a	66.42	10.8c	9.39	2.8c	1.24	73	100	36.8 **	6.9
Apple *(Pyrus malus L.)*	7.4a	21.75	8.6a	27.24	7.2a	20.87	9.2a	30.14	32.4	100	0.4	- -
Plum *(Prunus domestica L.)*	6.0a	43.06	3.6a	20.02	3.8a	21.70	3.0a	15.22	16.4	100	1.1	- -
Xylem cells	28.8a	40.02	23.0b	28.50	21.6b	25.99	7.6a	5.43	81	100	5.8 **	9.7
Unknown cells	20.0a	42.07	8.8c	12.29	13.6b	23.59	13.0b	22.05	55.4	100	6.2 **	5.6

L.S.D. = Least significant differences
Same letters do not significantly differ.

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القابلية النسبية لأشجار الفاكهة للأصابة بالقواقع الأرضية كما يتضح من الخلايا النباتية في مخلفات إخراجها

أنطوان ولسن تادرس، جوزيف متري نخلة، مرجريت عدلي رزق

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – جيزة – مصر.

تعتبر القواقع الأرضية من أنواع ثيبا بيسانا، ايوبانيا فيرميكيولاتا، هيليسلا فيستالس، وكوشيسلا اكيوتا من عائلة هيليسيلدي التابعة لرتبة بلوموناتا من الآفات الخطيرة في حدائق الفاكهة في محافظة البحيرة. درست القابلية النسبية لأصابة خمسة أنواع من الفاكهة (أشجار التفاح والبرتقال والكمثري والبرقوق ونباتات الموز) للأصابة بأربعة أنواع من القواقع الأرضية تحت الظروف المعملية خلال عام ١٩٩٨، وذلك عن طريق تعريف الخلايا النباتية لكل نوع فاكهة فى مخلفات إخراجها. أظهرت النتائج أن أنواع القواقع الأرضية: ثيبا بيسانا وهيليسلا فستاليس وكوشيسلا اكيوتا تفضل الكمثري بدرجة عالية جدا في حين أن أعلى تفضيل للنوع ايوبانيا فيرميكيولاتا لنباتات الموز، وجد أن البرتقال يلي الكمثري في الأفضلية لجميع أنواع القواقع، في حين لم تفضل أي من القواقع الأرضية كل من أشجار البرقوق والتفاح بالإضافة إلى نباتات الموز، وغالباً ما يهاجم القوقع الأرضي ثيبا بيسانا أشجار الكمثري والبرتقال أما القوقع الأرضي ايوبانيا فيرمكيولاتا فيهاجم الموز.