



**DEVELOPMENT AND REPRODUCTION OF THE TWO PREDATORY MITES
EUSEIUS scutalis AND *TYPHLODOROMIPS swirskii* (ACARI:
PHYTOSEIIDAE) AS AFFECTED BY LEAF TEXTURE OF
STRAWBERRY PLANTS**

[46]

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ABSTRACT

The predatory phytoseiid mites *Euseius scutalis* (El-Badry) and *Typhlodrompis swirskii* (Athias-Henriot) successfully developed and reproduced on strawberry leaves, infested with nymphs of the two-spotted spider mite *Tetranychus urticae* Kock as prey, of both Yaeel (smooth slight hairy) and Vantana (rough dense hairy) cultivars indicating a different effect of leaf surface on their behaviour at 27° C and 70% RH. Yaeel leaf was the most appropriate surface and Vantana ones was the least. Longevity was the greatest on Yaeel (31.92 and 28.48 days) and the shortest on Vantana (19.40 and 15.50 days) for each predator, respectively. The total number of eggs/ female was 39.00 and 41.34 on Yaeel and 21.02 and 19.68 on Vantana, respectively. Population of the two predators multiply 29.21 and 27.41 in a generation time of 15.78 and 13.93 days on Yaeel, whilst they were ($R_0=$ 14.77 and 14.79) and ($T=$ 14.26 and 12.55 days) on Vantana, respectively. Life table parameters also indicated that the smooth Yaeel leaves are better host-plants for predators in terms rm and e^{fm} . Trichomes characteristics on midrib and blade of Yaeel and Vantana strawberry leaves were determined.

INTRODUCTION

Increasing the demand of fresh strawberry, *Fragaria ananassa* Deuchesne, particularly in foreign markets, encourages growers to expand

strawberry cultivations in Egypt. Several high quality strawberry cultivars, as well, have been introduced and as a result, several pests and diseases have prevailed the fields. Some of them cause important economical damage, such as the two-spotted spider mite, *Tetranychus urticae* Kock. Now, it has been documented that the predatory phytoseiid mites could have achieved excellent control for phytophagous mites and several small insects (Graut and Richards, 1992; Abou-Awad *et al* 2000 and 2005), although there are several factors limit the efficiency of these natural enemies. Among these factors, leaf trichomes and morphological structures. Trichomes of host-plant could cause instability, variable and season-related mortalities of the predator by entrapment on the host leaves.

On the other hand, strawberry leaves have a large number of stomata (300-400/mm²) compared to many other plants, consequently, the leaves lose large amounts of water through transportation (Maas, 1984). The glandular trichomes, as well adversely affect predators by direct contact or by exposure to their volatiles (Kennedy *et al* 1991; Sutterlin and van Lenteren, 1997). The difference in behaviour and efficiency of the predatory phytoseiid mites, however, may also be related to the leaf texture (Elsawi, 1980; Aly, 1994; Ibrahim, 1997; Abou-Ellella, 1998; El-Banhawy *et al* 2000; Saber and Momen, 2000).

In this study, the effect of high density of strawberry trichomes and the other almost trichome-free on the development and reproduction of two predatory phytoseiid mites, common on strawberry cultivars, i.e. *Euseius scutalis* (El-

Badry) and *Typhlodrompis swirskii* (Athias-Henriot) was investigated. Life table parameters were also determined.

MATERIALS AND METHODS

Adult females of the predatory phytoseiid mites *E. scutalis* and *T. swirskii* were obtained from mass cultures maintained on the two-spotted spider mite *T. urticae* in experimental glass house at the National Research Centre, Dokki.

To study the effect of leaf texture, either rough or smooth, on the predators biology, two different strawberry cultivars were selected. Vantana with high density of trichomes and Yaeel with almost trichome-free, respectively.

1- Effect of strawberry leaf texture on oviposition, longevity and life table parameters

Predators were transferred to rearing substrates consisting of sweet potato leaves heavily infested with *T. urticae*. Fresh eggs (24h old) were used for biological studies. Leaf discs of both strawberry cultivars, 1.5cm in diameter, were used as rearing arenas in Petri dishes with the upper surfaces of the leaves placed downwards on water-saturated cotton. Newly hatched larvae (35 for every test) were confined, singly, in these arenas and supplied with *T. urticae* nymphs. Observations of the development were done twice a day, and reproduction and survival once a day. Every 4-5 days, the predators were transferred to new strawberry arenas and the hatched larvae reared until maturity. After the last moulting, males were put with the females for mating. Males were then transferred to new arenas and individually of each predator reared until their death. The eggs of the predators were removed daily from the arenas. An abundance of fresh nymphs of *T. urticae* as prey was replenished daily. The effectiveness of *E. scutalis* and *T. swirskii* as predators were tested in the laboratory at $27 \pm 1^\circ\text{C}$ and $70 \pm 5\%$ RH, and 12/12 h light/dark periods.

Data obtained were statistically analyzed by T-test and life table parameters were calculated according to Hulting *et al* (1990).

2- Examination and photographing of strawberry leaf texture

To determine the smooth and roughness of each strawberry cultivar, samples (4mm^2) from leaf area were promoted and immediately fixed in

glutaraldehyde (2.5%) from 24 h period at 4°C , then post-fixed in osmium tetroxide (1% O.O₄) for one hour at room ambient temperature (Harley and Ferguson, 1990). Through ascending concentrations of acetone, samples were dehydrated and coated by gold sputtering. Examination and photographing were carried out by Teal Scanning Electron Microscope (T330A) in the Central Laboratory of Faculty of Agriculture, Ain-Shams University.

RESULTS AND DISCUSSION

Characterizing the strawberry trichomes

Trichomes density, thickness and length on leaf midrib and blade of Yaeel and Vantana strawberry cultivars demonstrated in Table (1) and Figs. (1-4). Trichome length and density were an average of 1371 μm and 41.93, respectively, on midrib Vantana cultivar, whilst they were 709.93 μm and 19.13 in Yaeel showing significant differences. Density of trichomes on leaf blade was significantly higher in Vantana (10.3) compared with that of Yaeel cultivar (5.9). On the other hand, no significant detected in the length of blade trichomes for both strawberry cultivars. It is worth noting that thickness of midrib and blade trichomes were almost the same (Table 1). In general, midrib trichomes of Vantana cultivar were denser and have more sharply and pointed end than those of Yaeel strawberry plants.

Impact of strawberry leaf texture on development and fecundity of phytoseiid predators.

Results obtained on the duration of the different developmental stages and adult oviposition of *E. scutalis* and *T. swirskii* on both strawberry cultivars (Yaeel and Vantana) irrespective of smooth and roughness, respectively, are given in (Tables 2 & 3). Results clearly indicated that the immature stages of the two predatory mites developed to the adult stage on smooth leaves in a comparatively shorter periods, averaged 6.83 and 6.35 days, than their counterparts on roughness ones as their developmental durations averaged 8.30 and 7.09 days for *E. scutalis* and *T. swirskii*, respectively. This difference was significant ($P < 0.01$) in favour of Yaeel cultivar. Total longevity was greatest on smooth Yaeel leaves and shortest on roughness Vantana for the two predators, with the same trends observed in the adult of oviposition periods.

Table 1. Trichomes characteristics on midrib and blade of Yaeel and Vanata strawberry leaves

Strawberry cultivars	Midrib trichomes			Blade trichomes		
	No./cm ² , mean ± S.D.	Thickness (□m), mean ± S.D.	Length (□m), mean ± S.D.	No./cm ² , mean ± S.D.	Thickness (□m), mean ± S.D.	Length (□m), mean ± S.D.
Yaeel	19.13 ± 1.40 a	4.03 ± 0.21 a	709.93 ± 51.65 a	5.93 ± 0.34 a	4.37 ± 0.12 a	41.41 ± 2.20 a
Vanata	41.93 ± 2.34 b	4.11 ± 0.16 a	1371.0 ± 75.9 b	10.30 ± 0.64 b	4.12 ± 0.10 a	40.66 ± 3.27 a
T-Value	8.358**	1.547	7.200**	6.011**	0.304	0.191

Different letters in vertical columns denote significant difference (t-test, $P < 0.01$), ** highly significant.

Table 2. Effect of strawberry leaf texture on various stages and fecundity of the predatory phytoseiid mite *E. scutalis* females, at 27°C and 70% RH

Strawberry cultivars	Egg, mean ± S.D.	Larva, mean ± S.D.	Protonymph, Mean ± S.D.	Deuto-nymph, mean ± S.D.	Life cycle, mean ± S.D.	Pre-oviposition, mean ± S.D.	Oviposition, mean ± S.D.	Post-avioposition, mean ± S.D.	Longevity, mean ± S.D.	Life span, mean ± S.D.	Average no. of eggs, mean ± S.D.	Daily egg-laying rates, mean ± S.D.
Yaeel	2.17± 0.08	1.42± 0.10	1.46± 0.10	1.58± 0.10	6.83± 0.19a	1.42± 0.10	28.08± 0.45a	2.42± 0.12	31.92± 0.45a	38.58± 0.48a	39.00± 0.82a	1.39± 0.02a
Vanata	2.45± 0.11	1.85± 0.08	1.85± 0.08	2.15± 0.13	8.30± 0.21b	1.75± 0.19	15.50± 0.43b	2.80± 0.22	19.40± 0.51b	27.70± 0.56b	21.02± 1.02b	1.35± 0.05a
T-Value	2.10	3.20	2.87	3.44	3.99**	1.65	20.03**	1.87	18.55**	14.85**	13.87**	0.80

Different letters in vertical columns denote significant difference (t-test, $P < 0.01$), ** highly significant

Table 3. Effect of strawberry leaf texture on various stages and fecundity of the predatory phytoseiid mite *T. swirskii* females, at 27°C and 70% RH

Strawberry cultivars	Eggs, mean \pm S.D.	Larva, mean \pm S.D.	Protonymph, mean \pm S.D.	Deutonymph, mean \pm S.D.	Life cycle, mean \pm S.D.	Pre-oviposition, mean \pm S.D.	Oviposition, mean \pm S.D.	Post-oviposition, mean \pm S.D.	Longevity, mean \pm S.D.	Life span, mean \pm S.D.	Average no. of eggs, mean \pm S.D.	Daily egg-laying rates, mean \pm S.D.
Yael	2.13 \pm	1.35 \pm	1.30 \pm	1.57 \pm	6.35 \pm	1.60 \pm	27.52 \pm	1.00 \pm	28.48 \pm	34.74 \pm	41.34 \pm	1.52 \pm
	0.07	0.10	0.10	0.11	0.18a	0.00	0.54a	0.00	0.58a	0.53a	1.23a	0.04c
Vanata	2.14 \pm	1.45 \pm	1.50 \pm	2.00 \pm	7.09 \pm	1.89 \pm	13.86 \pm	1.20 \pm	15.50 \pm	22.72 \pm	19.68 \pm	1.43 \pm
	0.07	0.11	0.11	0.09	0.13b	0.200	0.60b	0.12	0.75b	0.78b	0.92b	0.04a
T Value	0.057	0.718	1.33	3.077	3.266**	3.981	16.990**	1.333	13.807**	12.835**	14.040**	1.677

Different letters in vertical columns denote significant difference (t-test, $P < 0.01$). ** highly significant.

Table 4. Effect of strawberry leaf texture on life table parameters of the predatory phytoseiid mites *E. scutalis* and *T. swirskii* females, at 27°C and 70% RH

Strawberry cultivars	Net reproduction rate (Ro)	Mean generation time (T)	Intrinsic rate of increase (rm)	Finite rate of increase (e^{rm})	Sex ratio (female/total)
<i>E. scutalis</i>					
Yael	29.21	15.784	0.213	1.238	0.75
Vanata	14.77	14.260	0.188	1.207	0.70
<i>T. swirskii</i>					
Yael	27.41	13.936	0.237	1.268	0.75
Vanata	14.79	12.554	0.191	1.239	0.70

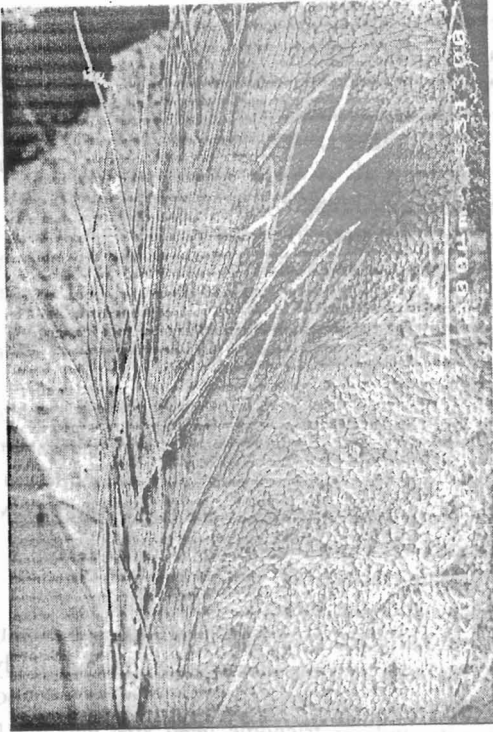


Fig.3. Trichome density on Vantana midrib



Fig. 4. Trichome density on Vantana blade

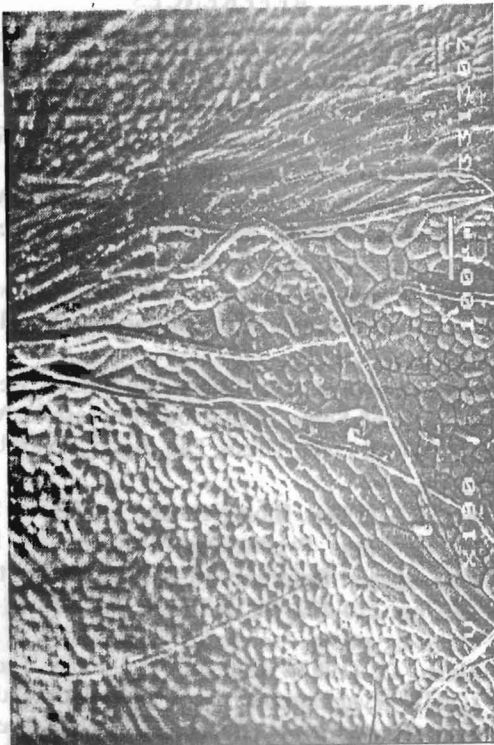


Fig. 1. Trichome density on Yaeel midrib.



Fig. 2. Trichome density on Yaeel blade.

On smooth Yaeel leaves, females of *E. scutalis* and *T. swirskii* laid a greater number of eggs, averaged 39.00 and 41.34 eggs/ female during 28.08 and 27.52 days, with a daily rate of 1.39 and 1.52 eggs than those of reared on roughness Vantana which laid an average of 21.02 and 19.68 eggs/ female during 15.50 and 13.86 days, with a daily rate of 1.35 and 1.43 eggs, respectively. It is of interest to note that the life span of both predatory phytoseiid mites also showed a distinct difference linked to smooth Yaeel cultivar.

The effect of strawberry leaf texture on life table parameters is shown in Table (4). Population of the predacious mites *E. scutalis* and *T. swirskii* could multiply 29.21 and 27.41 ($R_o = 29.21$ and 27.41) in a generation time of 15.78 and 13.93 days ($T = 15.78$ and 13.93) when predators reared on smooth yaeel leaves, while they were ($R_o = 14.77$ and 14.79) and ($T = 14.26$ and 12.55) on roughness Vantana cultivar, respectively. Under given conditions, the intrinsic rate of increase (r_m) were (0.213 and 0.237 individuals/female/day) on Yaeel and (0.188 and 0.191) on Vantana; while the finite rate of increase (e^{r_m}) were (1.238 and 1.268 female daughters/female/ day) and (1.207 and 1.239) on the two strawberry cultivars and predators, respectively. It was found, as well, that sex ratios for the two predators were the same. It is therefore concluded that smooth Yaeel leaves are a better host-plant for *E. scutalis* and *T. swirskii* in terms r_m and e^{r_m} .

DISCUSSION

The predatory phytoseiid mites, *E. scutalis* and *T. swirskii* successfully developed and reproduced on strawberry leaves of Yaeel (smooth dense hairy) and Vantana (rough dense hairy) indicating an effect of leaf surface on their behaviour. It was noted that the Yaeel leaves promoted a longer longevity, as well as, a longer oviposition period and consequently a marked higher number of eggs deposition; whereas, in contrast, Vantana leaves led to a shorter longevity and the predatory efficiency was extremely reduced. This means that some host plants favoured more suitable conditions for the development and biological activities of the phytoseiid predators. These findings are in accordance with those of several workers who reported that other predatory phytoseiid species showed different behaviour according to roughness of the plant surface. Generally, *Phytoseius* spp. are restricted to hairy plant leaves (Walter, 1992). Duso (1992) found that *Amblyseius ober-*

rans (Oud.) and *Typhlodromus pyri* (Scheuten) developed and reproduced better on smooth or slightly hairy leaves. Aly (1994) indicated that *Amblyseius swirskii* Athias-Henriot developed and reproduced on various leaf surfaces, but grape fruit (smooth leathery) was the best and guava (with coarse network of veins) was the worst. However, phytoseiid's preference for smooth surfaces, may be due to that the trichome density can hinder the searching of predator either by mechanically hindering the movement or through sticky exudates causing the mite to spend a large proportion of its time cleaning itself (Price et al 1980; Van Haren et al 1987).

Herein, it could be concluded that both Yaeel and Vantana strawberry leaves are adequate medium for the development and reproduction of *E. scutalis* and *T. swirskii*, although comparatively smooth Yaeel cultivar proved to be the most appropriate surface of the two predators. On the other hand, the biology of the predators are adversely affected by rough dense hairy of Vantana leaves as a rearing substrate. Additional study is required to find relationships between trichome density and/ or trichome head size and the percentage of predator entrapped.

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تأثر نمو وتكاثر المفترسان الأكاروسيان الأيوساس إسكوتالس والتفلو درومبيس إسويرزكاي بنسيج سطح الورقة لنباتات الفراولة

[٤٦]

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بيضة) على الصنف يائيل، وأدناه (٢١,٠٢ و ١٩,٦٨ بيضة) على الصنف فانتانا، لكلا من المفترسان على التوالي.

هذا وعند دراسة معايير الكفاءة الافتراضية لكلا من المفترسان، فقد وضح أن تعداد كل منهما قد تضاعف بما يعادل (٢٩,٢١ و ٢٧,٤١ مرة) في فترة جيل بلغت (١٥,٧٨ و ١٣,٩٣ يوما) على الصنف يائيل، بينما كانت تلك القيم (١٤,٧٧ و ١٤,٧٩ مرة) في (١٤,٢٦ و ١٢,٥٥ يوما) على الصنف فانتانا، لكلا من المفترسان، على التوالي، مما يثبت ويعضد أن كفاءة بعض المفترسات عند تربيتها على الأسطح الملساء هي الأفضل نوعيا عند مقارنتها بالتربية على الأسطح الخشنة ذات الشعيرات الزغبية الكثيفة، وخاصة مع قيم الكفاءة الافتراضية الأكثر دقة وأهمية والمتمثلة في المقدرة الذاتية الكامنة للأنثى الواحدة (rm) وكذلك نسلها الحقيقي (e^{rm}).

شملت الدراسة أيضا تحديد الخواص المورفولوجية للشعيرات الزغبية النامية على نصل الورقة وعرقها الوسطي من حيث أعدادها ومتوسط أطوالها وكثافتها في مساحة محددة، لكل من الصنفان يائيل وفانتانا.

نجحت تربية المفترسان الإيوسياس أسكوتالس والتفلو درومبيس إسويرزكاي اللذان ينتميان لفصيلة الغابتوسيدي (الشهيرة بكفاءة أنواعها الافتراضية في مجال المكافحة البيولوجية) على الأسطح السفلية لأوراق نباتات الفراولة ذات الكثافة المتباينة لشعيراتها الزغبية في المعمل على درجة حرارة 27م ورطوبة نسبية بلغت ٧٠%، حيث كان الصنف يائيل نموذجا لأسطح أوراق الفراولة الملساء تقريبا، والصنف فانتانا نموذجا آخر للأسطح الخشنة والعائقة لتجوال ونشاط المفترسان، مع استخدام أكروسات العناكب كفريسة حيوانية.

وقد أوضحت نتائج الدراسة أن الصنف يائيل الأملس هو الأمثل لنمو وتكاثر كلا من المفترسان، والعكس هو الصحيح مع الصنف فانتانا الخشن الملمس، وكانت فترة حياة أنثى المفترسان هي الأطول (٣١,٩٢ و ٢٨,٤٨ يوما) عند التربية على أوراق الصنف يائيل، والأقصر (١٩,٤٠ و ١٥,٥ يوما) على أوراق الصنف فانتانا، لكلا من المفترسان، على التوالي. بلغ أيضا متوسط معدل وضع البيض الكلي للأنثى الواحدة أقصاه (٣٩,٠٠ و ٤٣,٣٤