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Susceptibility of Some Fig (*Ficus carica* L.) Cultivars to Fig Wax Scale *Ceroplastes rusci* L. (Homoptera: Coccidae) in Jordan

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ABSTRACT

The susceptibility of seven fig, *Ficus carica* L. cultivars namely: Ajlouni, Byadi, Khartamoni, Khdari, Mwazi, Humari and Zraki to fig wax scale, *Ceroplastes rusci* L., was evaluated in 2006. Results showed that there were no fig cultivars immune to this pest, but some cultivars showed more susceptible than the others. Two months after infestation, Khdari had the highest number of scales, followed by Zraki, Byadi, and Mwazi, respectively, whereas the infestation level of Ajlouni, Khartamoni and Humari were as a minimum. Zraki had the highest percentage of insect survival two months after infestation. Distribution of scales over the transplants differed significantly. The highest number of scales was monitored on leaves of Zraki, while twigs and leaf petioles of Khdari were occupied with greatest number of wax scale. Results from the field survey confirmed the differences in susceptibility among different fig cultivars, with Khdari and Mwazi had the highest infestation level followed by Ajlouni and Humari, while the other cultivars showed intermediate infestation levels.

Keywords: *Ficus Carica*, Cultivars, *Ceroplastes Rusci*, Susceptibility, Jordan.

1. INTRODUCTION

Area planted to common fig, *Ficus carica* L., is estimated to 540 ha representing 0.64% of the total area cultivated to fruit trees (Department of Statistics, 2005). Furthermore, there are uncountable numbers of fig trees scattered in the home gardens or in the borders of olive, stone fruits and grape orchards. The total annual production of fresh fig is about 3400 MT (Department of Statistics, 2005).

Fig wax scale (FWS), *Ceroplastes rusci* L., is as a serious pest of fig in Jordan (Khasawinah and Talhouk, 1964; Talhouk, 1969; Mustafa-Al-Antary and Al-Momany, 1990; Mustafa-Al-Antary and Sharaf, 1994). This insect attacks leaves, twigs, and fruits. It damages the trees by sucking a large amount of plant sap as well as by coating the leaves with honeydew. The honeydew stimulates the growth of sooty mold (Abu-Huiege, 1962). Excreted honeydew and sooty mold on the vegetation interfere with some physiological processes of plant such as gas exchang and subsequently crop quality and quantity.

Certain fig cultivars have been reported to be less susceptible to FWS (Abu-Huiege, 1962), but comparative data on susceptibility of cultivars are lacking in the literature. The aim of the present study is to evaluate the susceptibility of different fig cultivars to FWS and some other biological aspects.

2. MATERIALS AND METHODS

2.1 Plastic House Experiment

This experiment was carried out at Mushaqar Regional Center which belongs to National Center for Agricultural Research and Extension (NCARE) in Madaba Governorate from June to October, 2006. The experimental site is located at about 790 m above sea level, and characterized by relatively cold winter and hot dry summer.

Seven 10 years-old fig cultivars namely; Ajlouni,

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Byadi, Khartamoni, Khdari, Mwazi, Humari and Zraki, which were planted as a mother orchard in the Center, were used in this study. Five cuttings (10 cm long) from current season growth of each cultivar were planted in plastic bags filled with clay and peat moss (1:1 v:v), irrigated once a week and kept outdoors until May. In June, the transplants were transplanted into 5 L. pots, kept under a plastic house conditions. Temperature was ranged between 15-35 ºC and 60-80% R.H. The experiment was arranged in a randomized compete block design with five replications.

Fig leaves with infested heavily 1st and 2nd nymphal stage of FWS were collected from infested fig tree from Madaba in June 10, 2006. Leaves with approximately 500 nymphs were attached to the top of each fig transplant. Upon leaves drying , nymphs moved to the leaves of the fig transplants and then settled down.

Cultivar susceptibility was determined by counting the average number of nymphal stage on day 10 after infestation. Pre-adult and adult scales were counted one month after infestation. The total number of gravid females established on the whole transplant were also counted two months after infestation .

Distribution of scales within the leaves was observed and recorded one week after infestation. The basal infested fig leaf from each cultivar was collected and ten scales were checked under a stereomicroscope for parasitism two months after infestation.

In August, the amount of honeydew secretions deposited on the leaves was determined using 0-5 scale. 0=no honeydew, 1=less than ¼ of the leaf area covered with honeydew, 2 = ½ of the leaf area covered with honeydew, 3=¾ of the leaf area covered with honeydew, 4= the whole leaf covered with light layer of honeydew, 5=the whole leaf covered with thick layer of honeydew.

Insect survival was determined on day 10 after infestation through dividing the number of alive nymphs by the original number and multiplied by 100. Survival rate after one month was calculated by dividing the number of adult and pre-adult by the number of live nymphs after 10 days and multiplied by 100. Survival rate after two months was calculated by dividing the number of gravid female by the number of adult and pre-adult after one month of infestation and multiplied by 100. Numbers of scales on leaves, twigs and petioles were also counted and recorded in mid-August. The data was subjected to one way analysis of variance with means separated by least significant difference (LSD) using MSTAT-C (Analytical software).

2.2. Field Evaluation

Field study was carried out during summer season, 2006 to evaluate the susceptibility of fig cultivars to FWS . 52 infested fig trees, representing 12 cultivars were included in this investigation that were grown in different regions of Jordan. There were 3-5 trees for each cultivar. Infestation levels on five leaves were scales as follows, 1= 100 scale insects, 2=500 scales, 3=1000 scales, 4=2000-5000 scales, 5= more than 5000 scales.Unknown cultivars were abandoned.

3. RESULTS

Results showed that none of the tested cultivars is resistant to FWS, but fig cultivars varied widely in their susceptibility (Table 1). 10 days after infestation, the mean number of nymphs was significantly higher on Khdari than other cultivars,while Humari and Ajlouni showed the lowest infestation level. The average number of pre-adults and adults determined one month after infestation was most abundant on Khdari and Byadi, but no significant differences were found between Byadi and Mwazi. Humari, Ajlouni and Khartamoni showed the lowest numbers with no significant differences among them. Tow months after infestation, the highest number of gravid scales, was on Khdari, while Humari, Ajlouni and Khartamoni were the lowest (Table 1). Khdari showed significantly the highest honeydew rating compared with other cultivars followed by Byadi. Honeydew rating did not differ significantly compared with the other cultivars (Table 1).

Percentage of survival of FWS on different cultivars 10 days after infestation showed that Khdari was significantly the highest (Table 2). High mortality of nymphs occurred in Humari and Ajlouni (Table 2). One month after infestation, Mwazi and Zraki showed the highest percentage of FWS survival, while Khartamoni was significantly the least. However, there were significant differences among the cultivars in survival after one month (Table 2). Percentage of survival increased after two months in all cultivars, but it was the highest on Zraki followed by Khdari, Byadi and Khartamoni with no significant differences (Table 2).

It was observed during the experiment that the nymphal development seemed to be delayed in some cultivars. After one month of infestation, most of the

scales on 'Ajlouni', 'Mwazi' and 'Humari' cultivars were in the early pre-adult stage ,while the other cultivars were occupied with pre-adults and adults.This difference disappeared after two months of infestation.

Within-leaf settled nymphs distribution varied between cultivars as observed. In 'Khdari', 10 days after infestation, nymphs settled mostly on tertiary veins on the periphery of leaves ,while it settled on tertiary veins between lobes in other cultivars. However, distribution of scales all over the transplant differed significantly among cultivars. Leaves of 'Zraki' encouraged the presence of highest number of scales ,while twigs and leaf petioles of 'Khdari' encouraged the highest number of scales (Fig. 1).

However, percentage of parasitism by the egg-predator *Scutellista cyanea* Motsch. (Pteromalidae: Hymenoptera) was 100% in all cultivars, two months after infestation.

All fig cultivars observed in the field appeared to exhibit various level of susceptibility to FWS. Khdari and Mwazi had the highest level followed by Ajlouni and Humari, while the rest cultivars had intermediate scale populations.

4. DISCUSSION

The results showed that there were no fig cultivars immune to fig wax scale , although some cultivars were more susceptible than the others (Table 1).Ten days after infestation ,Khdari had significantly the highest number of nymphs .One month after infestation ,Khdari and Baydi had significantly the highest number of pre-adults and adults compared with other cultivars .Two months after infestation, Khdari had significantly the highest number of gravid scale females compared with the other cultivars (Table 1). Ten days after infestation, Khdari had significantly the highest % survival compared with the other cultivars (Table 2).one month after infestation and two months after infestation, Zraki had significantly highest % survival ,although did not differ with Mwazi in case of one month after infestation (Table 2). However, there were several factors affecting susceptibility of figs to fig wax scale. The chemical contents of plant was considered to be as one of the most important factors, affecting, susceptibility (Ebadah *et .al.*, 2006). Variations in chemical composition among fig cultivars were previously reported (Sanchez *et .al.*, 2003). Doyle *et. al.* (2003) reported that incidence of fruit loss or quality deterioration of fig due to endosepsis, smut and other internal diseases was great in the Calimyrna fig cultivar. Koyuncu *et. al.* (1998) found that PH of fig fruit ranged between 4.2 and 5.3. Ateyyeh and Sadder (2006) examined fruit characteristics of six local Jordanian cultivars,and found that 'Khdari' and 'Byadi' fruits contained the least titrable acidity compared to 'Ajlouni' The role of the chemical contents in determination of fig susceptibility of different fig cultivars against scale insects needs further studies .

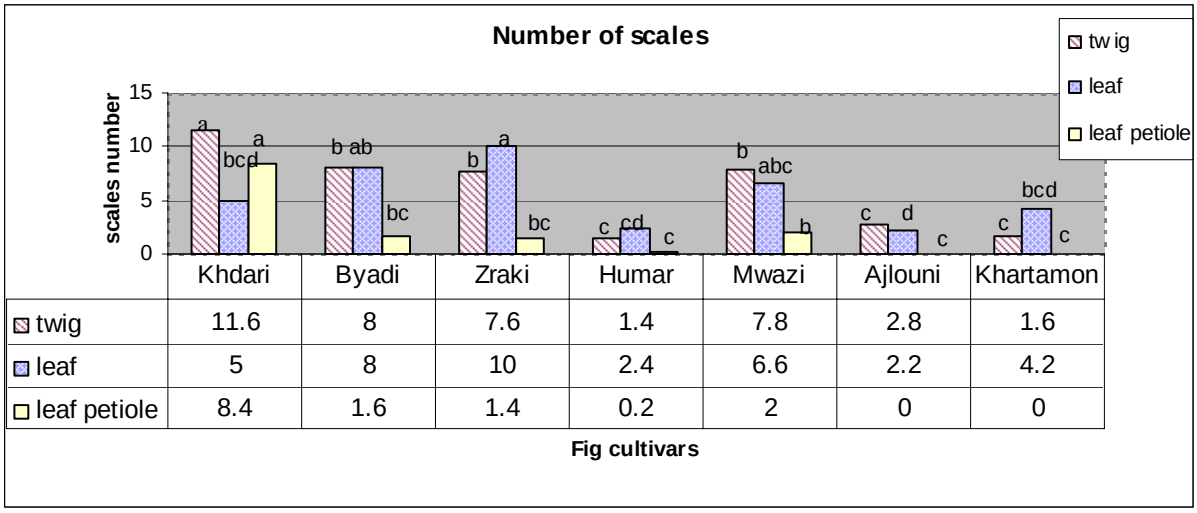

Fig. 1. Mean number of scales on leaves, twigs and petioles on different cultivars in mid-August.

Table 1. Mean number of nymphs, "pre-adults and adults" and gravid scales on seven fig cultivars in Mushaqar Regional Center from June to mid-August, 2006.

	Cultivars						
	Khdari	**Byadi**	**Zraki**	**Humari**	**Mwazi**	**Ajlouni**	**Khartamoni**
Average number of nymphs 10 days after infestation ±SE	186.8 ±11.9 a	148 ±2.0 b	106 ±6.0 c	66 ±6.8 d	106 ±6.0 c	59 ±5.5d	106±6.0 c
Average number of pre-adult and adult one month after infestation ±SE	38±1.8 a	34.2 ±1.8 ab	28.8 ±1.2 c	11.8 ±2.1d	33.2 ±1.3 b	12.4 ±0.8d	11.8 ±0.8d
Average number of gravid female two months after infestation ±SE	25 ±1.9 a	17.4 ±1.1 bc	19.6 ±1.4 b	4 d±0.6 d	16.4 ±1.1c	5 ±0.3d	6.0 ±1.0d
Honey dew rating ±SE	3.8 ±0.3 a	2.6 ± 0.2 b	1.4 ±0.2 c	1.6 ±0.2 c	1.2 ± 0.2 c	0.8 ± 0.2c	1.0 ± 0.0 c

Means within the same row followed by the same letters are not significantly different at $P \leq 0.05$.

Table 2. Percentage of survival of FWS population 10 days, one month and two months after infestation.

Cultivars	% of survival after 10 days ±SE	% of survival after one month ±SE	% of survival after two month ±SE
Khdari	37.2±2.33 a	20.9±2.1c	65.4± 2 ab
Byadi	21.8± 2.9 b	22.9±1.3 bc	52.4±4.2 abc
Zraki	21.2±1.2 b	27.4 ±1.6 ab	65.9±4.6 a
Humari	13.2±1.5 c	18.5 ±3.2 c	34.3±2.9 d
Mwazi	21.2±1.2 b	32.2 ±1.4 a	49.8±4.7 bcd
Ajlouni	11.9±1.1 c	21.4 ±2.5 c	42.4±4.2 cd
Khartamoni	21.2±1.2 b	11.3 ±0.9 d	53.2±11.9 abc

Means within the same column followed by the same letters are not significantly different at $P \leq 0.05$.

Table 3. Observations on the relative infestation of FWS on different fig cultivars in the field, 2006.

Cultivars	Numbers of samples	Mean of infestation level
Ajlouni	5	4
Byadi	4	3
Khartamoni	8	3.4
Khdari	10	4.8
Mwazi	10	4.6
Humari	2	4
Zraki	3	3.3
Swadi	3	3.3
Kharobi	1	3
Sfari	3	3
Ehmadi	1	3
Wild fig	2	4

Gibernau et al. (1997) reported differences in fig odor among different plant parts which resulted from specific substances,including phenol compounds (Martins *et. al.*, 2006). However, no attention have been paid for the differences in phenolic compounds among fig cultivars. Some workers reported the repellence effect of phenolic compounds against some homopteran insects. Hunsigi *et. al.* (2005) stated that resistance of sugarcane to woolly aphid *Ceratavacuna lanigera* Zehntner was due to the presence of large quantities of phenolic acid and terpenoids in sugarcane varieties.

Leaf physical characteristics of fig leaves could be another important factor determining fig susceptibility to FWS. It might play a major role in crawler acceptance to fig leaves and then adaptation to the cultivar. Differences in numbers of FWS at maturation were caused principally by differences in the initial success of settlement of crawlers. Condit (1947) stated that there were considerable variations in thickness, texture and upper and lower sinuses of different fig cultivars.

Fig wax scale showed differences in distribution within leaf and within plant (Fig. 1). This might be closely related to plant morphological characters. Washington and Walker (1990) reforted that non-uniform colonization of leaves often reflected variations in the depth, diameter, or frequency of vascular bundles between different hosts. Benassy (1961) found that nature of the substrate over which crawlers moved not only affects the rate and direction of movement, but also has influence on the duration of their wandering. A Correlation between susceptibility and leaf characteristics could be initiated, but this option seemed to rise several of questions unless description of our local cultivars are accomplished.

Leaves of 'Zraki' were attacted by the highest number of scales, while scale insects were abundant on twigs and leaf petioles of 'Khdari' (Fig. 1) . The distribution of insect all over the plant is strongly reflected on other aspects such as scale maturation, since nutrient concentrations are greatly differed between plant parts. The present results showed no differences in the time needed for maturity or the volume of the scales on the different cultivars. This result was inconsistent with finding of Daniel and Luck (1991) who reported differences in scales volumes of California red scales reared on different citrus cultivars.

Honeydew rating was significantly the highest in Khdari compared with the other cultivars (Table 1). The quality and quantity of sugar excreted by the insect still needed to be studied and correlated to carbohydrates, amino acids and protein contents of each cultivar.

According to the present results, no difference in *Scutellista cyanea* preference between scales reared on different fig cultivars. In contrast, Bigler and Delucchi (1981) found that *Opius concolor* and *Crytoptyx dacicidae* Mosi. (Pteromalidae: Hymenoptera) were mostly found on olive cultivars cultivated for oil extract.

This research showed differences in the susceptibility of seven fig cultivars in the plastic house experiment. Additional results from the field (Table3) proved to be a supported data in spite that, the results couldn't be statistically analyzed.

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حساسية بعض أصناف التين لقشرية التين الشمعية *Ceroplastes rusci* L. (Homoptera:Coccidae) في الأردن

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ملخـص

استهدف البحث دراسة حساسية سبعة أصناف من التين لقشرية التين الشمعية *Ceroplastes rusci* L. وهي: العجلوني والبياضي والخرطماني والخضاري والموازي والحماري والزراقي.

أظهرت الدراسة انه لا يوجد صنف مقاوم للإصابة إلا أن الأصناف تختلف في حساسيتها. الصنف خضاري كان من أكثر الأصناف السبعة حساسية حيث سجل أعلى عدد من الإناث الحاملة للبيض بعد شهرين من العدوى ثم تبعه الصنف زراقي ثم بياضي ثم موازي. أما الأصناف عجلوني وخرطماني وحماري فقد سجلت اقل عدد من الحشرات. وقد أظهرت الدراسة أن الحشرة تفضل التواجد على الأوراق في الصنف زراقي وتفضل الأفرع وأعناق الأوراق في الصنف "خضاري". الصنف زراقي سجل أعلى نسبة مئوية لبقاء الحشرة. نتائج المسح في الحقل تؤكد وجود فروق في حساسية التين لقشرية التين الشمعية، حيث كان الخضاري والموازي اعلى مستوى لصابة متبوعة بالعجلوني والحماري بينما ابدت بقية الاصناف مستوى متوسطاً من الاصابة.

الكلمات الدالة: أصناف التين، قشرية التين الشمعية، حساسية الأصناف، الأردن، *Ceroplastes rusci*.

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