Euseius scutalis (Athias-Henriot) a predator of *Eutetranychus orientalis* (Klein) (Acari: Phytoseiidae, Tetranychidae) in Jordan: Toxicity of some acaricides to *E. orientalis*

L.K. Tanigoshi, M. Bahdousheh[1], J.M. Babcock and R. Sawaqed[1]

Department of Entomology, Washington State University
Pullman, Washington 99164 - 6422, U.S.A

(1) Ministry of Agriculture, Jordan Valley Agricultural Services Project.

Abstract

Tanigoshi, L.K., Bahdousheh, M. and Babcock, J.M. 1990. *Euseius scutallis* (Athias - Henriot) a predator of *Euteranychus orientalis* (Klein) (Acari: Phytoseiidae, Tetranychidae) in Jordan: Toxicity of some acaricides to *E. orientalis*. Arab. J. Pl. Prot. 8(2):120–114.

Seasonal population densities of *Eutetranychus orientalis* (Klein) and the phytoseiid predator, *Euseius scutalis* (Athias-Henriot) on lemon in the Jordan Valley were determined with a mite brushing machine during 1986-87. Six of the nine study sites were either managed as biological control groves or had never been treated with pesticides. Population trends for *E. orientalis* throughout the Jordan Valley were seasonally abundant from midsummer through December; moreover, *E. scutalis* populations responded numerically and functionally to their prey's propensity to attain economic levels during the same time period in non- sprayed groves. Groves receiving pesticidal applications in April and May caused marked reductions of the phytoseiid predator for several months. Slide-dip biossay procedure indicated low levels of tolerance in *E. orientalis* populations to four commonly applied acaricides in Jordan citrus.

Key words: lemon, mites population dynamics, acaricides, Jordan.

Introduction

The predaceous phytoseiid mite, *Euseius scutalis* (Klein) is commonly found on *Citrus* spp. in the Jordan Valley (20) This predator is widely distributed throughout North Africa, the Middle East, southern Spain and India (4,15). Bonufour and McMurtry (12) list 29 families of shrubs and trees common to temperate, arid areas from which *E. scutalis* has been collected. These host plants, especially of the genera *Gossypium, Vitis, Persea, Pyrus, Solanum,* and *Citrus* are often infested with tetranychid spider mites. Citrus is commonly infested with injurious populations of the citrus brown mite, *Eutetranychus orientalis* (Klein) during late summer and fall in the Jordan Valley. Jeppson et al. (9) also reported its occurrence on citrus in Turkey, Palestine, Egypt, India, Pakistan ans Taiwan.

E. scutalis, like most species of *Euseius,* is a facultative predator (6, 12, 14) and readily feed and reproduce on pollen (e.g., iceplant, corn, date, cotton) or will dietarily shift to acarine and insect predation. *E. scutalis* will readily feed on several species of spider mites, citrus flat mite, *Brevipalpus lewisi* McGregor, citrus thrips, *Scirtothrips citri* (Mouton) and sweetpotato whitefly, *Bemisia tabaci* (Gennadius) (2, 13). This propensity toward polyphagy has enabled *E. scutalis* to switch its diet during periods of low citrus brown mite densities to seasonal occurrence and abundance of windborne pollens during the mild winter and spring climes of the Jordan Valley. Furthermore, the ability of *E. scutalis* to develop and reproduce at rates commensurate to spider mite prey (2) will enhance its survivorship and synchronize its numerical response with population increase of *E. orientalis* (11, 18, 19).

The objectives of our research were to characterize the population dynamics of both mite species on lemon; assess the impact of the predator on *E. orientalis* infestations; and to bioassay commonly recommended acaricides on Jordanian citrus for *E. orientalis* control.

Materials and Methods

Populations of *E. orientalis* and *E. scutalis* were monitored from December 1986 to November 1987 throughout the Jordan River Valley. Nine lemon orchards, *Citrus limon* Burmann were sampled; these were selected with regard to location, pesticide usage histories, and cultural practices. Population densities of both mites were assessed weekly from 20 randomly sampled canopy leaves from each of 5 trees per orchard and individually processed with a mitebrushing machine (8). Motile life stages for each species were counted with a stereomicroscope.

Lemon groves from the northern Jordan Valley monitored were: Al Mashare, an abandoned grove which was never culturally managed for pests or irrigated; Al Yabis and North Shuna groves were under biological control, with the latter grove having not received pesticidal sprays as part of a spherical mealybug, *Nipaecoccus viridis* (Newstead), biological control program. Three groves monitored in the central region were: Ghor Kebed, a chemically managed grove; Deir

Alla, a biological control grove, Ma'adi, another chemically managed grove. Study groves grom the southern valley were: Al Kafrein, a chemically managed grove; Al Rama, a biological control grove; and South Shuna grove which has never been treated with pesticides. The aforementioned biological control lemon groves received no insecticidal or acaricidal treatments in 1986 – 1987 unless otherwise noted.

A slide-dip bioassay, similar to that used by Babcock and Tanigoshi (1), was used to assess the level of *E. orientalis* responses to four acaricides. Each compound was mixed with distilled water and serially diluted to produce appropriate concentrations. Four concentrations for each acaricide and a distilled water control were used. Approximately 100 robust adult females were used per concentration; each of the five replicates consisted of 20 females placed on their dorsum to double sided sticky tape attached to the end of a standard microscope slide. Slides were gently agitated in each pesticide concentration for 5 s and then allowed to air dry. The slides were then held in open microscope slide boxes under laboratory conditions of ca. 25±2°C. Mortality was measured after 24 and 48 h by lightly touching the appendages of each mite with a fine camel hair brush and observing for movement. Living mites were scored as those that were able to actively move their legs and/or mouth parts. After counts were adjusted for control mortality, a computer probit analysis (17) was used to construct concentration/ mortality curves. Only recommended formulations of acaricides registered for use in Jordan were used for all testing: cyhexatin 50WP, bromoprophylate 50EC, fenbutatin- oxide 50WP and amitraz 25WP.

Results and Discussion

Population Trends. *E. orientalis* populations throughout the Jordan Valley attained peak levels of abundance during late Novemver through December (Figs. 1 – 3). This period of heavy infestation coincides with seasonally lower temperatures and increased rainfall. The mite passes late January through February as mature, quiescent, fertilized orange-red over-wintering females. There are ca. 8 – 10 generations of citrus brown mite per year on lemon in the Jordan Valley. *E. scutalis* remained variously abundant from February to October in the biological control groves at Ak Yabis and North Shuna (Fig. 4) During this time *E. scutalis* regulated citrus brown mite to noneconomic population densities because their predatory responses were not mitigated by inappropriate application (s) of pesticides. An excellent example of seasonal dietary switching between citrus brown mite and airborne pollens occurred in the Al Yabis biological control grove. Population trends for *E. scutalis* in the Al Yabis grove indicate that ca. 0.5predator per leaf will regulate *E. Orientalis* during late winter and spring months. The propensity to feed and reproduce on alternate food sources will allow the arid adapted *E. scutalis* to survive and reproduce before populations of *E. orientalis* resurge to economic levels (2).

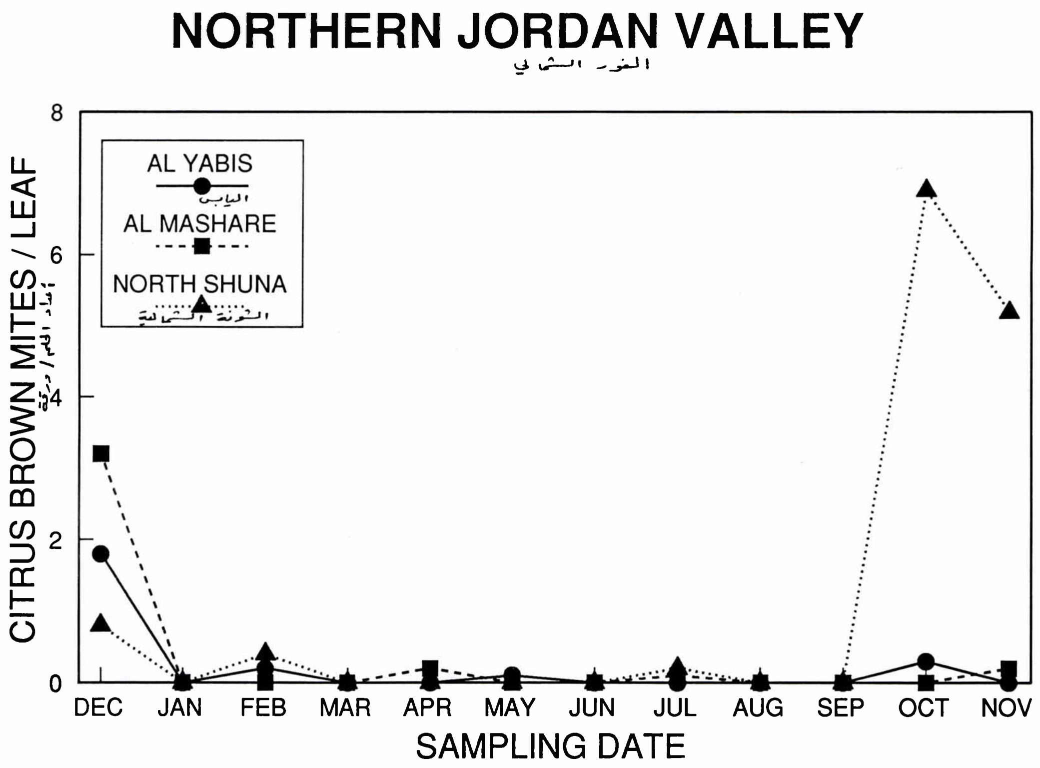

Figure 1. Population levels of *Eutetranychus orientalis* (Klein) in lemon in the northern Jordan Valley, 1986 – 1987.

شكل رقم 1. مستويات كثافة *E. orientalis* في الغور الشمالي 1986 ـ 1987.

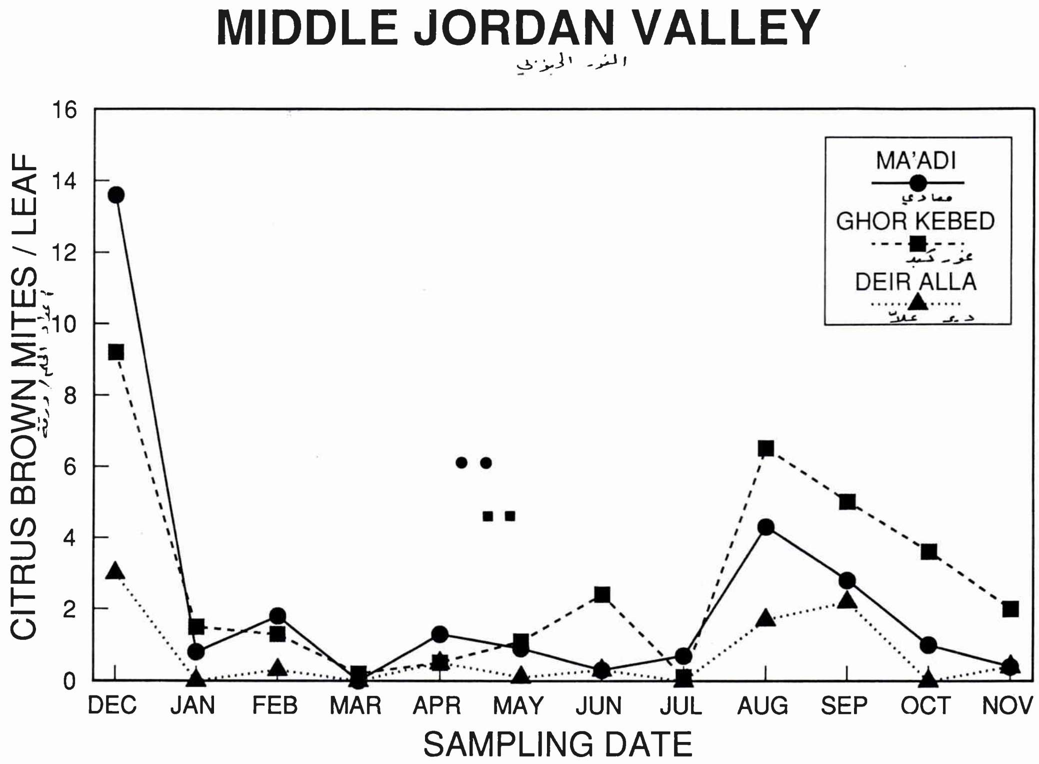

Figure 2. Population levels of *Eutetranychus orientalis* (Klein) in lemon in the middle Jordan Valley, 1986 - 1987. Applications of cyhexatin and chlorpyriphos ■ respectively at Ghor Kebed methidation ● at Ma'adi.

شكل رقم 2. مستويات كثافة *E. orientalis* في الغور الأوسط 1986 ـ 1987. استخدام سايهكساتين وكلوربيريفوس، ■ ، علـى التوالي، في «غـور كبد» وميتيداثيون ● في المعادي.

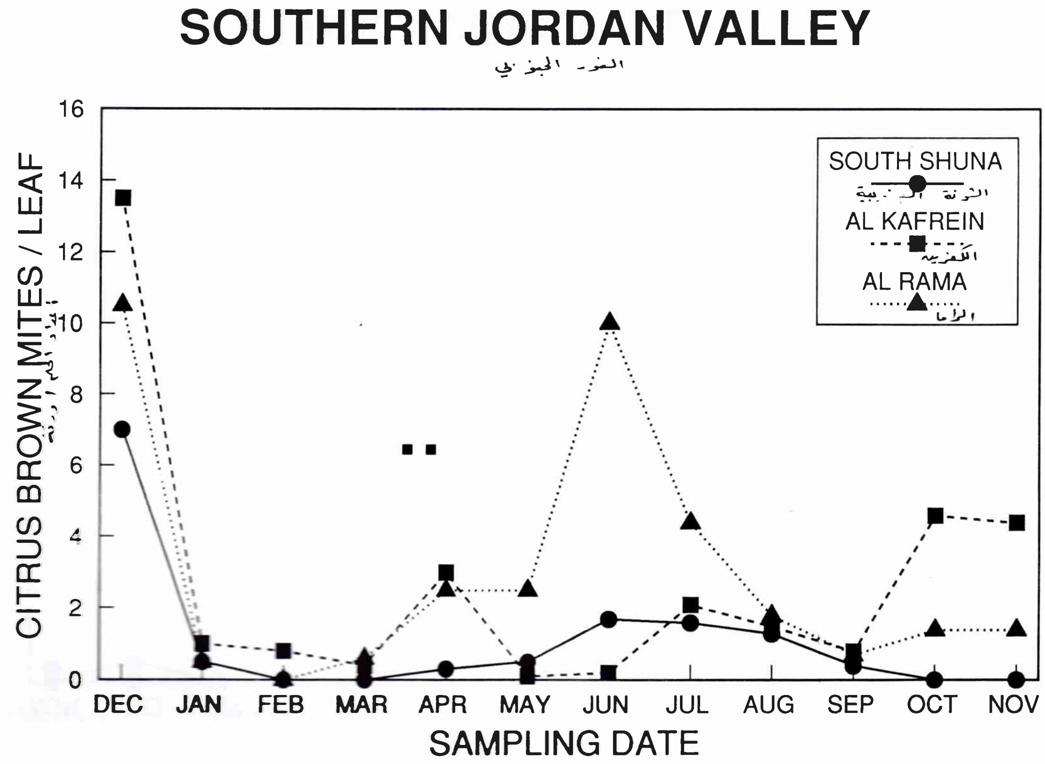

Figure 3. Population levels of *Eutetranychus orientalis* (Klein) in lemon in the southern Jordan Valley, 1986 - 1987. Applications of fenbutatin - oxide ■ at Al Kafrein.

شكل رقم 3. مستويات كثافة *E. orientalis* في الغور الجنوبي، 1986 ـ 1987. استخدام فينبوتاتين ـ أكسيد ■ في الكفرين.

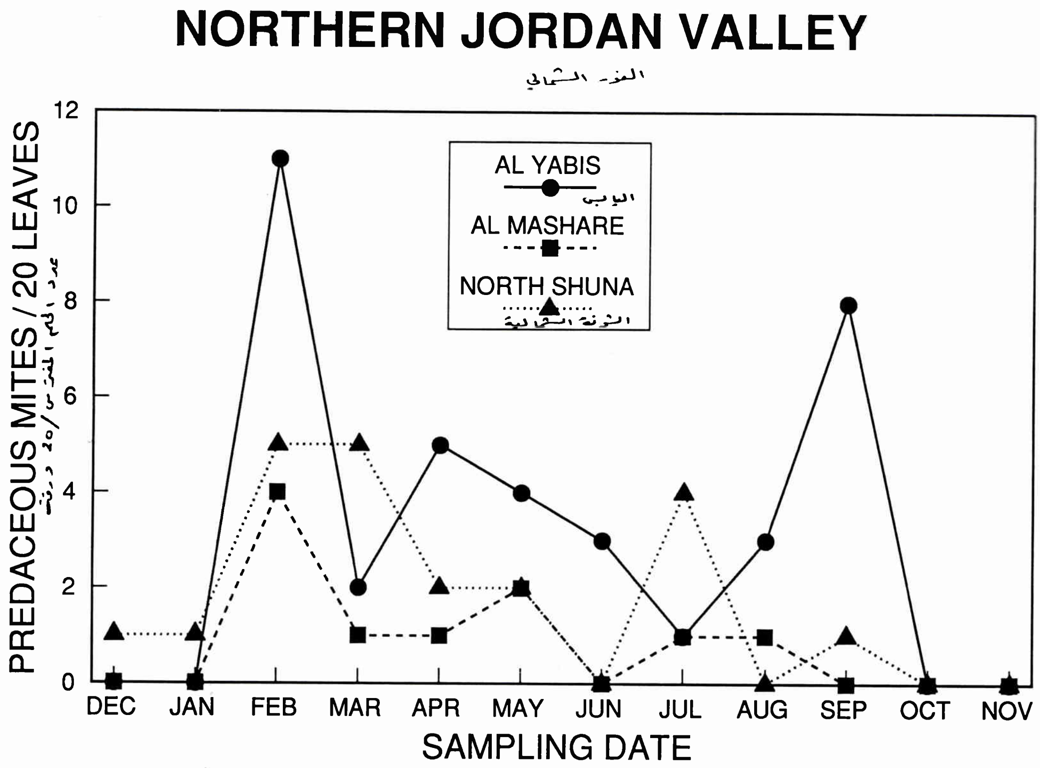

Figure 4. Population levels of *Euseius scutalis* (Athias- Henriot) in lemon in the northern Jordan Valley, 1986 – 1987.

شكل رقم 4. مستويات كثافة *E. scutalis* في بيارات الحمضيات بالغور الشمالي 1986 ـ 1987.

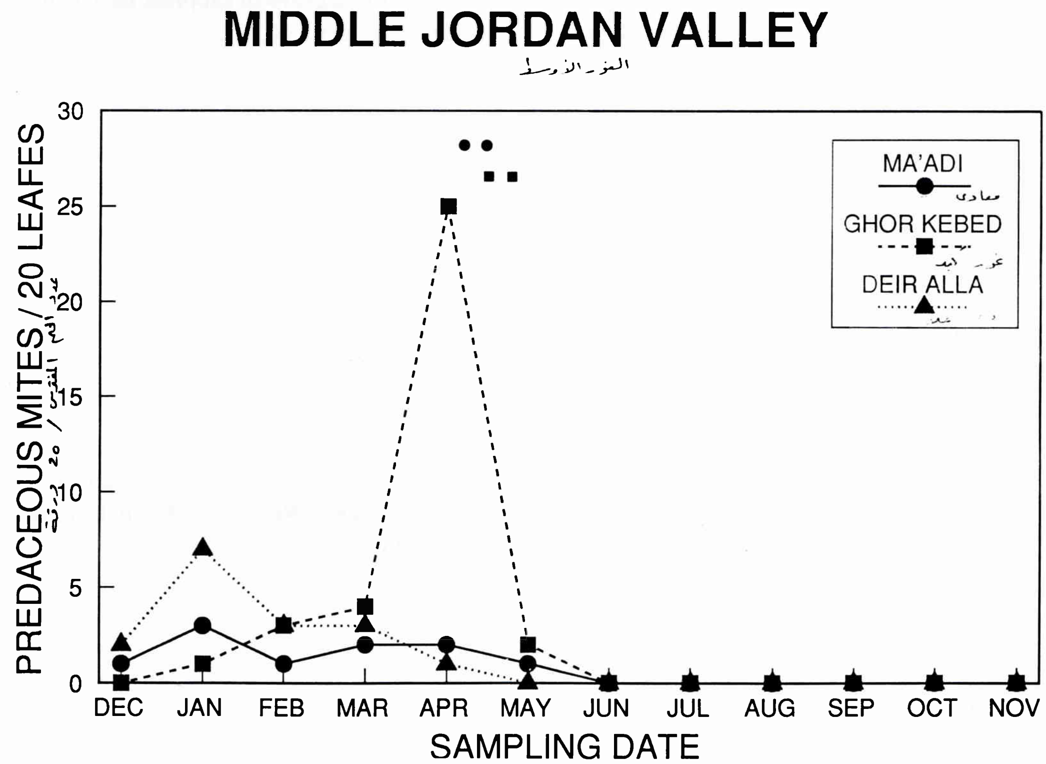

Figure 5. Population levels of *Euseius scutalis* (Athias- Henriot) in lemon in the middle Jordan Valley, 1986- 1987. Applications of cyhexatin and chlorpyriphos ■ respectively at Ghor Kebed and methidathion ● at Ma'adi.

شكل رقم 5. مستويات كثافة *E. scutalis* في بيارات الحمضيات بالغور الشمالي 1986 - 1987. استخدام سايهكساتين وكلوربيريفوس ■ على التوالي (غور كبيد، وميثداثيون ● في المعادي.

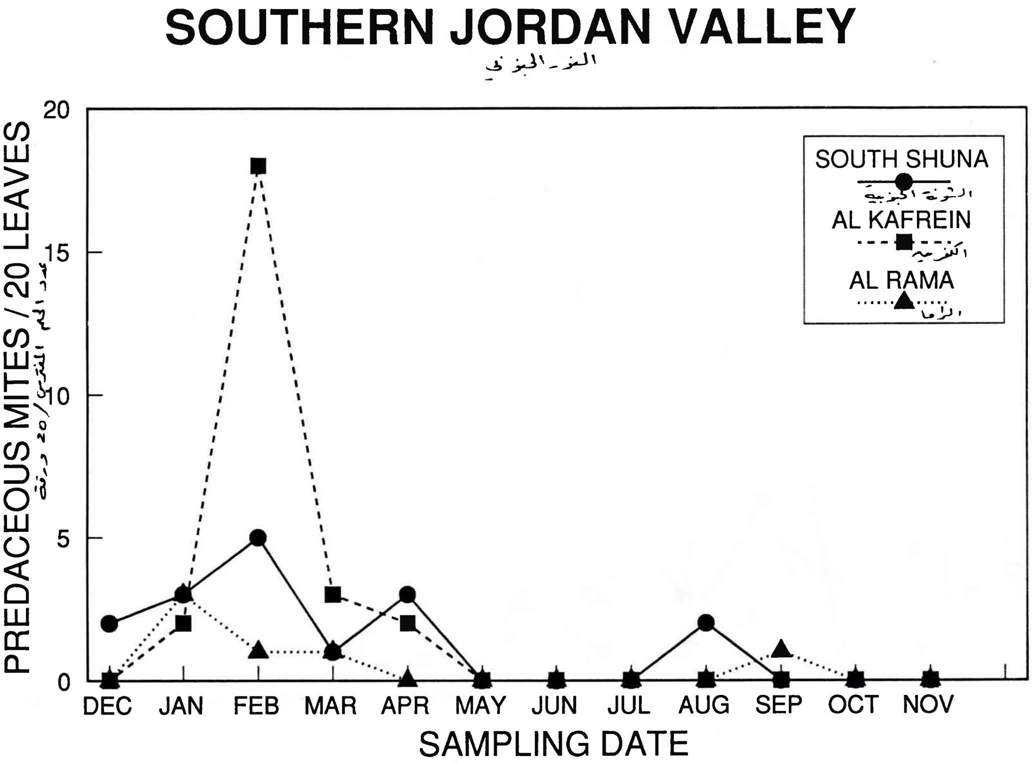

Figure 6. Population levels of *Euseius scutalis* (Athias-Henriot) in lemon in the southern Jordan Valley, 1986 – 1987. Applications of fenbutatin- oxide . ■ at Al Kafrein.

شكل رقم 6. مستويات كثافة *E. scutalis* في بيارات الحمضيات بالغور الجنوي 1986 ـ 1987 استخدام فينبوتاتين ـ اكسيد ■ في الكفرين.

By June, *E. scutalis* populations had declines to undetectable levels in the middle and southen Jordan Valley (Figs. 5 – 6); this decline and concomitant favorable weather conditions resulted in numerical increases of *E. orientalis*. However, the quiescent overwintering female *E. scutalis* began responding to the emergence of overwintering citrus brown mite females and to increasing levels of pollen from flowering lemon, ornamentals and uncultivated plants during February to May.

At the Ghor-Kebed grove, the applications of cyhexatin and chlorpyrifos in mid-April reduced *E. sculatis* populations to nearly zero in two weeks. Within one month the citrus brown mite had attained a density of ca. 2 per leaf and 6 per leaf by August. *E. scutalis* in the Ghor-Kebed grove remained near the zero level for another seven months following the late June application of chlorpyrifos. The cover sprays of methidathion that were applied in mid-April in the Ma'adi grove resulted in resurgence of *E. orientalis* to 3 – 5 / leaf through the summer months. These acaricidal applications were ill advised because population trends at treatment were similar to those in the biological control grove at Deir Alla.

In the near absence of spring populations of *E. scutalis* at Deir Alla, the citrus brown mite never exceeded 2 per leaf in 1987. Population levels for *E. orientalis* and *E. scutalis* in the Deir Alla grove indicate exellent prey regulation. Moreover, the predator's densities were so low during the mid-summer through fall months in the middle and southern Jordan Valley lemon groves that they were barely detectable in our 20 leaf samples. Fenbutatin-oxide was applied twice in April to the Al Kafrein grove to suppress uneconomic levels of ca. 3 spider mites per leaf. The organotin treatments reduced the citrus brown mite populations to near zero for about two months; *E. orientalis* populations rebounded to levels commensurate to the nonchemical South Shuna and Al Rama biological control groves by July. As indicated earlier, *E. scutalis* is capable of regulating late season spider mite densities despite difficulties encountered in our measuring detectable predator populations.

Bioassays. *E. orientalis* from pesticide treated and untreated groves in the Ministry of Agriculture's Deir Alla Research Station were bioassayed. At 48 h post-dip, amitraz, cyhexatin and bromopropylate were about equal in toxicity, while fenbutatin-oxide slightly less toxic (Table 1). All 48h LC_{50} values were well below recommended field rates for these acaricides. Recommended field rates in parentheses followed by respective sprayed and nonsprayed grove LC_{50} values in g (AI)/ liter for each acaricides were: fenbutatin-oxide 50WP (0.75), 0.27, 0.23; cyhexatin (0.27), 0.06, 0.09; bromopropylate (0.36), 0.1, 0.09; and amitraz (0.40), 0.06, and 0.14. A distinct correlation between nonsprayed and sprayed blocks and their respective LC_{50}'s that would be indicative of resistance development was not ascertained from these bioassays. This apparent lack of correlation may be due to the recent shift toward biological control of pest arthropods. *E. orientalis* populations in the region are probably still undergoing pesticide selection and are inbreeding for resistant and susceptible alleles; this, as more of the Jor-

Table 1. Bioassay response of *E. orientalis* from treated and untreated Lemon groves at the Deir Alla Research Station, Jordan, 1987.

جدول 1. استجابة الحلم *E. orientalis* المجموع من بيّارات معاملة وغير معاملة في محطة بحوث دير علاّ ـ الأردن للاختبار الحيوي.

Population العشائر	Acaricide مبيد العناكب	24 h LC_{50}[a]	24 h 95% C.I.	24 h Slope الانحدار	48 h LC_{50}[a]	48 h 95% C.I.	48 h Slope الانحدار
Treated	Fenbutain-oxide	0.45	0.38 – 0.53	2.37	0.27	0.24 – 0.32	3.13
Untreated	Fenbutatin-oxide	0.62	0.52 – 0.74	2.38	0.23	0.20 – 0.26	4.28
Treated	Cyhexatin	0.63	0.38 – 1.04	0.91	0.06	0.05 – 0.08	2.27
Untreated	Cyhexatin	0.15	0.13 – 0.17	2.99	0.04	0.03 – 0.95	1.93
Treated	Bromopropylate	0.51	0.43 – 0.60	2.45	0.10	0.08 – 0.12	1.73
Untreated	Bromopropylate	0.21	0.13 – 0.32	0.79	0.09	0.07 – 0.11	1.66
Treated	Amitraz	0.62	0.46 – 0.82	1.23	0.06	0.04 – 0.07	2.05
Untreated	Amitraz	0.56	0.40 – 0.80	1.26	0.14	0.12 – 0.16	2.93

[a]g (Al) /liter.

غ (مادة فعالة)/ لتر

dan Valley growers continues to reduce applications of hard pesticides for control of spherical mealybug and citrus brown mite.

Table 2. Response of *E. orientalis* from two lemon groves in the southern Jordan Valley, 1987.

جدول 2. استجابة *E. orientalis* المجموع من بيّارتين في جنوبي الغور، عام 1987.

المبيد Acaricide	الجرعة Rate[a]	الشونة الجنوبية South Shunab 24h	48h	الكفرين Al Kafrein 24h	48h
Fenbutatin-oxide	0.375	100	100	76	100
Cyhexatin	0.137	100	100	34	37
Bromopropylate	0.360	80	98	97	100
Amitraz	0.200	100	100	100	100

[a]g (Al)/ liter.
[b]percent mortality.

أ مادة فعالة (غ)/ لتر
ب النسبة المئوية للموت

E. orientalis from South Shuna and Al Kafrein groves were found to be collectively more susceptible than those populations bioassayed from the middle region of the Jordan Valley. The rates shown for fenbutatin-oxide, cyhexatin, bromopropylate and amitraz were respectively, 0.5, 0.5, 0 and 0.5-fold less than recommended field rates on citrus grown in Jordan (Table 2). Except for amitraz, females from the pesticide managed Al Kafrien grove were more tolerant at 24h than from the South Shuna biological control grove. These differences are apparent from data that compare their percent mortalities. After 48h, no difference was observed between the populations for three of the compounds; however, slide dip mortality for female *E. orientalis* from Al Kafrien to cyhexatin at 0.5-fold the field rate was only 37 percent after 48hr. Cyhexatin resistance in the Tetranychidae has recently become a serious problem (3, 5, 10, 16). Based on these reports, the potential for cross resistance in this family is likely where cyhexation has been widely used. If organotin resistance in the Jordan Valley is present, its successful mitigation may be based on recent research conducted to evaluate resistance reversion in field selected populations (7). They reported successful organotion resistance reversion of the two-spotted spider mite, *Tetranychus urticae* Koch, through the alternative use of acaricides that did not confer subsequent organotin cross resistance.

الملخص

تانيفوشي، ل.ك وم، بهدوشة وج، م. بابكوك. ور. صواكد. 1990. المفترس *Euseius scutalis* (Athias – Henriot) على الحلم *Eutetranychus orientalis* (Klein) (Acari: Phytoseiidae, Tetranychidae): سمية بعض مبيدات الحلميات على الحلم *E. orientalis*. مجلة وقاية النبات العربية 8 (2):120-114.

تم تحديد الكثافة الموسمية لمجتمع الحلم *E. orientalis* (Klein) والمفترس *E. scutalis* (Athias-Henriot)، في تسع بيارات للحمضيات بوادي الأردن، باستخدام فرشاة آلية خاصة، وذلك في الموسم 87/1986. وكانت ستة من المواقع التسعة المدروسة مدارة على أساس المكافحة الحيوية، أو لم يتم استخدام مبيدات الآفات فيها مطلقاً. أظهرت النتائج أن الكثافة الموسمية للحلم *E. orientalis* كانت عالية في كافة أرجاء غور الأردن بدءاً من منتصف الصيف وحتى كانون الأول/ ديسمبر. وأن مجتمعات المفترس قد استجابت عددياً ووظيفياً للكثافة العددية لمجتمعات فريستها. ووصلت، في البيارات غير المعاملة، إلى مستويات اقتصادية خلال الفترة الزمنية نفسها. أما أعداد المفترس في البيارات التي تمّ رشها

بالمبيدات في نيسان/ أبريل، وأيار/ مايو، فقد انخفضت بشكل ملحوظ لعدة أشهر. وقد أشارت نتائج التجارب الحيوية في المختبر، أنّ لمجتمعات *E. orientalis* مستويات تحمُّل منخفضة لأربعة مبيدات حلم شائعة الاستخدام في بيارات الحمضيات وبخاصة فينبوتاتين - أكسيد، سيهكساتين، بروموبروبليت وأمتيراز.

كلمات مفتاحية: حمضيات/ موالح، حلميات، ديناميكية المجتمع، مبيدات حلم، الأردن.

References

المراجع

1. Babcock, J. M. and Tanigoshi. L. K. 1988. Resistance levels of *Typhlodromus occidentalis* (Acari: Phytoseiidae) from Washington apple orchards to ten pesticides. Exp. Appl. Acarol. 4: 151 - 157.
2. Bounfour, M. and McMurtry. J. A. 1987. Biology and ecology of *Euseius scutalis* (Athias-Henriot) (Acarina: Phytoseiidae). Hilgardia 55: 1-23.
3. Croft, B. A., Miller, R. W. Nelson R. D. and Westigard. P. H. 1984. Inheritance of early-stage resistance to formetanate and cyhexatin in *Tetranychus urticae* Koch (Acari: Tetranychidae). J. Econ. Entomol. 77: 574 - 578.
4. Daveshvar, H. 1980. Some predatory mites from northern and western Iran. Entomol. Phytopathol. Appliq. 48: 15 - 87.
5. Edge, V. E. and James D. G. 1986. Organotin resistance in *Tetranychus urticae* (Acari: Tetranychidae) in Australia. J. Econ. Entomol. 79: 1477 - 1483.
6. ElBadry, E. A. and ElBenhawy. E. M. 1968. Effect of different species on the development and fecundity of *Amblyseius gossipi* (Acarina: Phytoseiidae). Z. Angew. Entomol. 62: 247 - 251.
7. Flexner, J. L., Westigard P. H. and Croft. B. A. 1988. Field reversion of organotin resistance in the two-spotted spider mite (Acari: Tetranychidae) following relaxation of selection pressure. J. Econ. Entomol. 81: 1516 - 1520.
8. Henderson, C.F. and McBurnie. H. B. 1943. Sampling techniques for determining populations of the citrus red mite and its predators. U.S. Det. Agric. Cir. 671.
9. Jeppson, L. R., Keifer H.H. and Baker. E. W. 1975. Mites injurious to economic plants. Berkeley and Los Angeles: Univ. Calif. Press. 614pp.
10. Keena, M. A. and Granett. J. 1987. Cyhexatin and propargite resistance in populations of spider mites (Acari: Tetranychidae) from California almonds. J. Econ. Entomol. 80: 560 - 564.
11. Kennett, C.E., Flaherty, D.L. and Hoffmann, R.W. 1979. Effects of windborne pollens on the population dynamics of *Amblyseius hibisci* (Acarina: Phytoseiidae). Entomophaga 24: 83 - 98.
12. McMurtry, J. A. 1977. Some predaceous mites (Phytoseiidae) on citrus in the mediterranean region. Entomophaga 22: 19 - 30.
13. Meyerdirk, D.E. and Coudriet. D.L. 1986. Evaluation of two biotypes of *Euseius scutalis* (Acari: Phytoseiidae) as predators of *Bemesia tabaci* (Homoptera: Aleyrodidae). J. Econ. Entomol. 79: 659 - 663.
14. Muma, M. H. and Denmark. H. A. 1970. Phytoseiidae of Florida. Arthropods of Florida and neighboring land areas. 6: 1 - 150. Fla. Dep. Agric. Div. Plant Ind.
15. Narayanan, E.S. and Kaur. R.B. 1960. Two new species of the genus *Typhlodormus* Scheuten from india (Acarina: Phytoseiidae). Proc. Indian Acad. Sci. 51: 1 - 8.
16. Pree, D. J. 1987. Inheritance and management of cyhexatin and dicofol resistance in the european red mite (Acari: Tetranychidae). J. Econ. Entomol. 80: 1106 - - 1112.
17. SAS Institute. 1985. SAS user's guide: statistics, version 5 ed. SAS Institute, Cary. N.C.
18. Tanigoshi, L.K., Fargerlund, J. and Nishio-Wong. J.Y. 1981. Significance of temperature and resources to the development biology of *Amblyseius hibisci* (Chant) (Acarina, Phytoseiidae). Z. Angew. Entomol. 92: 409 - -419.
19. Tanigoshi, L.K., Fargerlund, J., Nishio-Wong. J.Y. Tanigoshi, L.K., Fargerlund, J., Nishio-Wong J.Y. and Griffiths. H.J. 1985. Biological control of citrus thirps, *Scirtothrips citri* (Thysanoptera: Thripidae), in southern California citrus groves. Environ. Entomol. 14: 733 - 741.
20. Tanigoshi, L. K., Bahdousheh M. and Sawaqed. R. 1988. Citrus brown mite. Jordanian Ministry of Agriculture Tech. Bull. JVASP 44: 1 - 3.