Abstract


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 sp. in the Jordan Valley (20). This predator is widely distributed throughout North Africa, the Middle East, southern Spain and India (4,15). Bonfouir 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 and 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 mitre-rushing 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 from 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, bromopropylate 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 November 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 Al 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. 0.5 predator 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).

![Graph](image)

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

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 methida- tion ● at Ma'adi.

**SOUTHERN JORDAN VALLEY**

Figure 3. Population levels of *Eutetranychus orientalis* (Klein) in lemon in the southern Jordan Valley, 1986 – 1987. Applications of fenbutatin – oxide ■ at Al Kafrein.
Figure 4. Population levels of *Euseius scutalis* (Athias-Henriot) in lemon in the northern Jordan Valley, 1986-1987.

Figure 5. Population levels of *Euseius scutalis* (Athias-Henriot) in lemon in the middle Jordan Valley, 1986-1987. Applications of cyhexatin and chlorpyrifos ■ respectively at Ghor Kebed and methidathion ● at Ma‘adi.
By June, *E. scutalis* populations had declines to undetectable levels in the middle and southern 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 groove, the applications of cyhexatin and chlorpyrifos in mid-April reduced *E. scutalis* 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 groove 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 groove resulted in resurgence of *E. orientalis* to 3 - 5 per 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 excellent 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 LC50 values were well below recommended field rates for these acaricides. Recommended field rates in parentheses followed by respective sprayed and nonsprayed grove LC50 values in g (AI)/ liter for each acaricide 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 LC50’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.

<table>
<thead>
<tr>
<th>Population</th>
<th>Acaricide</th>
<th>LC₅₀ (mg A/t)</th>
<th>95% C.I.</th>
<th>Slope (LC₅₀)</th>
<th>LC₅₀ (mg A/t)</th>
<th>95% C.I.</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated</td>
<td>Fenbutain-oxide</td>
<td>0.45</td>
<td>0.38 - 0.53</td>
<td>2.37</td>
<td>0.27</td>
<td>0.24 - 0.32</td>
<td>3.13</td>
</tr>
<tr>
<td>Untreated</td>
<td>Fenbutain-oxide</td>
<td>0.62</td>
<td>0.52 - 0.74</td>
<td>2.38</td>
<td>0.23</td>
<td>0.20 - 0.26</td>
<td>4.28</td>
</tr>
<tr>
<td>Treated</td>
<td>Cyhexatin</td>
<td>0.63</td>
<td>0.38 - 1.04</td>
<td>0.91</td>
<td>0.06</td>
<td>0.05 - 0.08</td>
<td>2.27</td>
</tr>
<tr>
<td>Untreated</td>
<td>Cyhexatin</td>
<td>0.15</td>
<td>0.13 - 0.17</td>
<td>2.99</td>
<td>0.04</td>
<td>0.03 - 0.95</td>
<td>1.93</td>
</tr>
<tr>
<td>Treated</td>
<td>Bromopropylate</td>
<td>0.51</td>
<td>0.43 - 0.60</td>
<td>2.45</td>
<td>0.10</td>
<td>0.08 - 0.12</td>
<td>1.73</td>
</tr>
<tr>
<td>Untreated</td>
<td>Bromopropylate</td>
<td>0.21</td>
<td>0.13 - 0.32</td>
<td>0.79</td>
<td>0.09</td>
<td>0.07 - 0.11</td>
<td>1.66</td>
</tr>
<tr>
<td>Treated</td>
<td>Amitraz</td>
<td>0.62</td>
<td>0.46 - 0.82</td>
<td>1.23</td>
<td>0.06</td>
<td>0.04 - 0.07</td>
<td>2.05</td>
</tr>
<tr>
<td>Untreated</td>
<td>Amitraz</td>
<td>0.56</td>
<td>0.40 - 0.80</td>
<td>1.26</td>
<td>0.14</td>
<td>0.12 - 0.16</td>
<td>2.93</td>
</tr>
</tbody>
</table>

a₄ (Al)/liter.

found to be collectively more susceptible than those populations bioassayed from the middle region of the Jordan Valley. The rates shown for fenbutain-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 Kafrein 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 Kafrein 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 organotin 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.

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

<table>
<thead>
<tr>
<th>Population</th>
<th>Acaricide</th>
<th>Rate</th>
<th>South Shunab</th>
<th>Al Kafrein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated</td>
<td>Fenbutain-oxide</td>
<td>0.375</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Untreated</td>
<td>Fenbutain-oxide</td>
<td>0.137</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Treated</td>
<td>Cyhexatin</td>
<td>0.360</td>
<td>80</td>
<td>98</td>
</tr>
<tr>
<td>Untreated</td>
<td>Cyhexatin</td>
<td>0.200</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

α₄ (Al)/liter.

βpercent mortality.

*a Mada Fuala (ع) / لنر

b نسبة المنثو للموت

*E. orientalis* from South Shuna and Al Kafrein groves were

الملخص


**E. orientalis** تم تحديد الكثافة المستمرة للمجتمع الحرم، في قمع *E. scutalis* (Athias-Henriot) (Klein) بيات للحماض بوني الاردن، باستخدام فرشاة الماء خاصة، وذلك في الموسم 1986. وكانت ستة من المواسم التسعية المدرجة مدة على أساس المكافحة الحيوية، أو لم يتم استخدام مبيدات الآفات فيها مطلقاً. أظهرت النتائج أن

**E. orientalis** كانت عالية في كافة أرجاء غور الأردن بدلاً من منتصف الصفح وحتى كانون الأول/ديسمبر. وأُستخدم المفترس قد استُلقي بعددًا ووظيفياً للكثافة العددية لمجتمعات فرستها. ووصلت إلى البيانات غير المعتمدة، إلى سنوات اقتصادية خلال الفترة الزمنية نفسها. أما أعداد المفترس في البيانات التي تم رشها
References


