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# Occurrence and Population Dynamics of Mites Associated with Citrus Trees at Menoufia Governorate

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## ABSTRACT

Population dynamics and species composition of phytophagous and predatory mites in citrus orchards were determined from January to December 2016 at Shenofa locality, Shebin El-Kom, Menoufia governorate, Egypt. The survey revealed the occurrence of phytophagous mites as: *Panonychus citri* (McGregor), *Eutetranychus orientalis* (Klein) (Tetranychidae); *Phyllocoptruta oleivora* (Ashmed) (Eriophyidae); *Brevipalpus californicus* (Banks) (Tenuipalpidae) and *Tydeus californicus* (Banks) (Tydeidae), representing the most common phytophagous species found in citrus orchards. In addition, two predatory mite species of two families were recorded as: *Amblyseius swirskii* Athias-Henriot (Phytoseiidae) and *Agistemus exsertus* González (Stigmaeidae) were found to be the most abundant predatory species inhabiting citrus leaves. The population fluctuation of phytophagous and predacious mites on studied citrus varieties was varied according to citrus varieties and sampling dates reaching its highest peak, in most cases, during September. Navel orange recorded the highest numbers of *P. oleivora* in comparison with other varieties of citrus (290.31 indiv. /10 leaves), while the highest number of *P. citri* and *B. californicus* were 85.63 and 45.3 indiv. /10 leaves on Balady orange. The obtained result indicated that the maximum and minimum temperature and relative humidity expressed as an insignificantly positive during 2016 season on the population of *P. oleivora*, *E. orientalis*, *B. californicus*, *T. californicus*, *A. swirskii* and *A. ex*ertus, but highly significance difference was obtained between population of *P. citri* only. Finally, it could be concluded that winter months are suitable for applying different biological control agents including predatory mites where pests are lowest in numbers and the optimum environmental factors are present as well.

**Key words:** Ecology, phytophagous mites, predacious mites, citrus, Egypt.

## INTRODUCTION

Citrus is the most popular fruit crop in Egypt. Egypt is one of the largest citrus-growing countries and remains a leading orange producer and exporter in the world (FAOSTAT, 2008 and GAIN-USDA, 2015). Faunistic studies focusing on citrus mites in Egypt are still limited. Few comprehensive surveys were conducted by other authors, i.e., Zaher *et al.* (1970); Rasmy *et al*. (1972); Zaher (1984a & b, 1986); Kandeel and Nassar (1986); Rahil and Abd-El-Halim (2000). The most phytophagous mite families injurious to citrus included Tetranychidae, Tenupalpidae and Eriophyidae which cause great damage to plants that affect crop quantity and quality. Nowadays, the environmental preference of various mite pests on citrus plants has gained a significant importance in pest control programs. However, few studies were carried out with regard to the influence of different biotic and abiotic factors on the population dynamics of the different phytophagous and predacous mites on citrus (Yassin, 2004). Ibrahim (1988) mentioned that sour, navel, acidless orange varieties and mandarin were infested with *Eutetranychus orientalis* (Klein), *Brevipalpus obovatus* Donnadieu, *B. phoenicis* (Geijskes) and *B. californicus* (Banks) in Egypt, also they found species of families Phytoseiidae, Cheyletidae and Stigmaeidae inhabiting citrus varieties and studied the population density of phytophagous and predaceous mites in relationship to ecological factors.

The objective of this study was to evaluate the population dynamics of different phytophagous and predacious mites inhabiting citrus orchards at Shebin Elkom, Menoufia governorate.

## MATERIALS AND METHODS

### Survey and population dynamics of phytophagous and predacious mites associated with citrus varieties

Samples of plant leaves were randomly collected every month from four citrus varieties: *Citrus reticulate* (Balady mandarin), *C. sinensis* var. Seefi (Valencia orange), *C. sinensis* var. Naval (Seedless orange) and *C. sinensis* var. Balady (Balady orange). The samples were taken from Shenofa village, Menoufia governorate for a year. Thirty random leaves samples were picked from each treatment (treatment consists of 20 trees). Samples were collected in polyethylene bags, tightly closed and transferred to the laboratory for later examination by stereoscopic-microscope. Mite individuals were counted then mounted singly in Hoyer's medium for the identification process. Labels containing all necessary information were registered on each slide. Mounted slides were kept for 24 hrs in electric oven at 40–50 $^{\circ}$C. Mite identification was done according to the world references keys.

## RESULTS AND DISCUSSION

Population of phytophagous and predacious mites associated with four citrus varieties at Shenofa orchards, Shebin El-Kom, Menoufia governorate were conducted.

**Survey and population density of phytophagous mites infested Balady mandarin:**

The regular inspections of citrus trees throughout 2016 season revealed that the dominant mites were: *Panonychus citri* (McGregor), *Eutetranychus orientalis* (Klein) (Tetranychidae), *Phyllocoptruta oleivora* (Ashmed) (Eriophyidae), *Brevipalpus californicus* (Banks) (Tenuipalpidae) and *Tydeus californicus* (Banks) (Tydeidae). The cumulative level of these mites on Balady mandarin throughout the period of study is given in Table (1). Data show an annual peak for most mites during September recording respectively 5.66, 35.66, 3.0 and 7.66 indiv./10 leaves for *P. citri*, *P. oleivora*, *E. orientalis* and *T. californicus*. The tenuipalpid mite, *B. californicus* showed maximum level of abundance during April (6.66 indiv./10 leaves). Population of mites was decreased along January where the population declined to zero. This indicated that total number of phytophagous mites were respectively 25.3, 75.98, 12.3, 30.97 and 37.97 mites for *P. citri*, *P. oleivora*, *E. orientalis*, *B. californicus* and *T. californicus*. The result also showed that September harbored more population of mites (55.31 indiv.).

Statistical analysis of data in Table (1) indicated that there were significant differences in total number of phytophagous mites infested Balady mandarin leaves along 2016 season, where there were significant differences between September (55.31) and other months (LSD5% =3.79). Furthermore, there were significant differences in total number *P. oleivora* (75.98) and other species ($LSD_{5\%}$ =11.48).

**Survey and population density of phytophagous mites associated with Valencia orange:**

The obtained results in Table (2) show change in population of phytophagous mites on Valencia orange. As the population changed during the different sampling dates reaching maximum level of abundance during September for most collected mites, except for *E. orientalis* which appeared with negligible numbers during the course of the present study. The population during September recorded respectively 5.66, 71.66, 6.66 and 6.0 indiv./10 leaves for *P. citri*, *P. oleivora*, *B. californicus* and *T. californicus*.

Statistical analysis of data in Table (2) indicated that there were significant differences in total number of phytophagous mites infested Valencia orange leaves along 2016 season, where there were significant differences between September (90.98) and other months (LSD5% =3.07). Furthermore, there were significant differences in total number of *P. oleivora* (185.3) and other species ($LSD_{5\%}$ =13.2).

**Survey and population density of phytophagous mites associated with Navel orange:**

It is clearly evident from data presented in Table (3) that the total number of phytophagous mites on Navel orange during 2016 season were respectively 37.97, 290.31, 14.3, 34.63 and 36.63 indiv./10 leaves for *P. citri*, *P. oleivora*, *E. orientalis*, *B. californicus* and *T. californicus*. As noticed from the obtained results, population of mites was negligible during the winter months (December, January and February), but the peak was recorded on September for the same mites species.

Table (1): Average numbers of phytophagous mites /10 leaves on Balady Mandarin during 2016 season

| Month | Average numbers of mites/10 leaves | | | | | Total | °C | | R.H. % |
|---|---|---|---|---|---|---|---|---|---|
| | *P. citri* | *P. oleivora* | *E. orientalis* | *B. californicus* | *T. californicus* | | Max. | Min. | |
| Jan. | $0^{d}$ | $0^{e}$ | $0^{c}$ | $0^{c}$ | $0^{e}$ | 0h | 22.4 | 14.2 | 66.0 |
| Feb. | $0^{d}$ | $0^{e}$ | $0.33^{c}$ | $1.33^{c}$ | $0^{e}$ | $1.66^{gh}$ | 22.0 | 12.0 | 69.0 |
| Mar. | $0^{d}$ | $0^{e}$ | $0.66^{bc}$ | $4^{b}$ | $1^{de}$ | $5.66^{fg}$ | 25.4 | 16.6 | 62.0 |
| Apr. | $2.66^{c}$ | $0^{e}$ | $1^{bc}$ | $6.66^{a}$ | $5^{b}$ | $15.32^{d}$ | 24.3 | 17.9 | 67.0 |
| May | $2.66^{c}$ | $0^{e}$ | $0.33^{c}$ | $1^{c}$ | $4.66^{bc}$ | $8.65^{ef}$ | 27.8 | 15.5 | 58.3 |
| Jun. | $3^{bc}$ | $0^{e}$ | $2.66^{a}$ | $3^{b}$ | $2.66^{cd}$ | $11.32^{de}$ | 37.1 | 18.8 | 65.0 |
| Jul. | $3.33^{bc}$ | $0^{e}$ | $1.33^{b}$ | $0^{c}$ | $4^{bc}$ | $8.66^{ef}$ | 38.2 | 22.4 | 63.0 |
| Aug. | $4.33^{ab}$ | $12.33^{c}$ | $1.33^{b}$ | $0^{c}$ | $4^{bc}$ | $21.99^{c}$ | 30.5 | 24.3 | 67.0 |
| Sept. | $5.66^{a}$ | $35.66^{a}$ | $3^{a}$ | $3.33^{b}$ | $7.66^{a}$ | $55.31^{a}$ | 39.4 | 27.4 | 65.3 |
| Oct. | $2.66^{c}$ | $22.33^{b}$ | $1.66^{b}$ | $5.66^{a}$ | $5.33^{b}$ | $37.64^{b}$ | 34.6 | 22.9 | 69.0 |
| Nov. | $1^{d}$ | $5.66^{d}$ | $0^{c}$ | $4.33^{b}$ | $2.66^{cd}$ | $13.64^{d}$ | 35.0 | 20.4 | 59.6 |
| Dec. | $0^{d}$ | $0^{e}$ | $0^{c}$ | $1.66^{c}$ | $1^{de}$ | $2.66^{gh}$ | 23.6 | 24.4 | 59.2 |
| Total | 25.3C | $75.98^{A}$ | $12.3^{D}$ | $30.97^{BC}$ | $37.97^{B}$ | 182.52 | - | - | - |
| $LSD_{5\%}$ | 1.37 | 2.89 | 0.95 | 1.13 | 1.54 | 3.79 | - | - | - |

LSD5% for mite species = 11.48

Means in each column or row followed by the same letter (s) are not significantly different at 5%level.

Table (2): Average numbers of phytophagous mites/10 leaves on Valencia orange during 2016 season

| Month | Average numbers of mites/10 leaves | | | | | Total | °C | | R.H. % |
|---|---|---|---|---|---|---|---|---|---|
| | *P. citri* | *P. oleivora* | *E. orientalis* | *B. californicus* | *T. californicus* | | Max. | Min. | |
| Jan. | $0^{e}$ | $0^{d}$ | $0^{c}$ | $1.33^{de}$ | $0^{d}$ | $1.33^{f}$ | 22.4 | 14.2 | 66.0 |
| Feb. | $0^{e}$ | $0^{d}$ | $0.66^{bc}$ | $0^{e}$ | $0^{d}$ | $0.66^{f}$ | 22.0 | 12.0 | 69.0 |
| Mar. | $0.66^{e}$ | $0^{d}$ | $0.66^{bc}$ | $2^{d}$ | $0.33^{d}$ | $3.55^{f}$ | 25.4 | 16.6 | 62.0 |
| Apr. | $2.66^{cd}$ | $0^{d}$ | $1.33^{a}$ | $1.66^{d}$ | $1.66^{c}$ | $7.31^{e}$ | 24.3 | 17.9 | 67.0 |
| May | $3.33^{cd}$ | $0^{d}$ | $0^{c}$ | $2^{d}$ | $2^{c}$ | $7.33^{e}$ | 27.8 | 15.5 | 58.3 |
| Jun. | $3^{cd}$ | $0^{d}$ | $0^{c}$ | $1^{de}$ | $3.66^{b}$ | $7.66^{e}$ | 37.1 | 18.8 | 65.0 |
| Jul. | $2.33^{d}$ | $0^{d}$ | $0^{c}$ | $2.33^{d}$ | $4.33^{b}$ | $8.99^{e}$ | 38.2 | 22.4 | 63.0 |
| Aug. | $2^{d}$ | $35.33^{c}$ | $0^{c}$ | $3.66^{bc}$ | $5.33^{a}$ | $46.32^{c}$ | 30.5 | 24.3 | 67.0 |
| Sept. | $5.66^{a}$ | $71.66^{a}$ | $1^{b}$ | $6.66^{a}$ | $6^{a}$ | $90.98^{a}$ | 39.4 | 27.4 | 65.3 |
| Oct. | $4^{be}$ | $48.66^{b}$ | $0^{c}$ | $4.66^{b}$ | $2^{c}$ | $59.32^{b}$ | 34.6 | 22.9 | 69.0 |
| Nov. | $4.66^{ab}$ | $29.66^{c}$ | $0^{c}$ | $2.66^{cd}$ | $0.66^{cd}$ | $37.64^{d}$ | 35.0 | 20.4 | 59.6 |
| Dec. | $2.33^{d}$ | $0^{d}$ | $0^{c}$ | $1^{de}$ | $0^{d}$ | $3.33^{f}$ | 23.6 | 24.4 | 59.2 |
| Total | $30.63^{B}$ | $185.3^{A}$ | $3.65^{C}$ | $28.96^{B}$ | $25.97^{B}$ | 274.42 | - | - | - |
| $LSD_{5\%}$ | 1.08 | 10.10 | 0.58 | 1.07 | 1.08 | 3.07 | - | - | - |

$LSD_{5\%}$ for mite species = 13.2
Means in each column or row followed by the same letter (s) are not significantly different at 5% level.

Table (3): Average numbers of phytophagous mites/10 leaves on Navel orange during 2016 season

| Month | Average numbers of mites/10 leaves | | | | | Total | °C | | R.H. % |
|---|---|---|---|---|---|---|---|---|---|
| | *P. citri* | *P. oleivora* | *E. orientalis* | *B. californicus* | *T. californicus* | | Max. | Min. | |
| Jan. | $0^{f}$ | $0^{d}$ | $0^{f}$ | $0^{f}$ | $0^{e}$ | 0h | 22.4 | 14.2 | 66.0 |
| Feb. | $0^{f}$ | $0^{d}$ | $0^{f}$ | $1.66^{ef}$ | $0^{e}$ | $1.66^{gh}$ | 22.0 | 12.0 | 69.0 |
| Mar. | $2.66^{de}$ | $0^{d}$ | $0.33^{ef}$ | $3^{de}$ | $0^{e}$ | $5.99^{efgh}$ | 25.4 | 16.6 | 62.0 |
| Apr. | $4.33^{d}$ | $0^{d}$ | $1^{cdef}$ | $1.66^{ef}$ | $1.66^{de}$ | $8.65^{ef}$ | 24.3 | 17.9 | 67.0 |
| May | $6^{c}$ | $0^{d}$ | $1^{cdef}$ | $0^{f}$ | $1^{de}$ | $8.0^{efg}$ | 27.8 | 15.5 | 58.3 |
| Jun. | $7.66^{b}$ | $0^{d}$ | $0.66^{def}$ | $0^{f}$ | $2.33^{d}$ | $10.65^{e}$ | 37.1 | 18.8 | 65.0 |
| Jul. | $9.66^{a}$ | $0^{d}$ | $1.66^{cd}$ | $3^{de}$ | $9.66^{a}$ | $23.98^{d}$ | 38.2 | 22.4 | 63.0 |
| Aug. | $3.33^{d}$ | $93.66^{b}$ | $3.33^{a}$ | $6.66^{b}$ | $7.33^{b}$ | $114.31^{b}$ | 30.5 | 24.3 | 67.0 |
| Sept. | $4^{d}$ | $115.66^{a}$ | $2.66^{ab}$ | $8.33^{a}$ | $8.66^{ab}$ | $139.31^{a}$ | 39.4 | 27.4 | 65.3 |
| Oct. | $1.33^{ef}$ | $68.33^{c}$ | $2^{bc}$ | $5^{c}$ | $4.33^{c}$ | $80.99^{c}$ | 34.6 | 22.9 | 69.0 |
| Nov. | $0^{f}$ | $12.66^{d}$ | $1.33^{cde}$ | $3.66^{d}$ | $1.66^{de}$ | $19.31^{d}$ | 35.0 | 20.4 | 59.6 |
| Dec. | $0^{f}$ | $0^{d}$ | $0.33^{ef}$ | $1.66^{ef}$ | $0^{e}$ | $1.99^{fgh}$ | 23.6 | 24.4 | 59.2 |
| Total | $37.97^{B}$ | $290.31^{A}$ | $14.3^{C}$ | $34.63^{B}$ | $36.63^{B}$ | 413.84 | - | - | - |
| $LSD_{5\%}$ | 1.54 | 8.03 | 0.95 | 1.31 | 1.55 | 7.2 | - | - | - |

$LSD_{5\%}$ for mite species = 8.55
Means in each column or row followed by the same letter (s) are not significantly different at 5% level.

Table (4): Average numbers of phytophagous mites/10 leaves on Balady orange during 2016 season

| Month | Average numbers of mites/10 leaves | | | | | Total | °C | | R.H. % |
|---|---|---|---|---|---|---|---|---|---|
| | *P. citri* | *Ph. oleivora* | *E. orientalis* | *B. californicus* | *T. californicus* | | Max. | Min. | |
| Jan. | $0^{e}$ | $0^{d}$ | $0^{d}$ | 0e | $1^{bc}$ | 1g | 22.4 | 14.2 | 66.0 |
| Feb. | $0^{e}$ | $0^{d}$ | $0^{d}$ | $0.33^{e}$ | $0^{c}$ | $0.33^{g}$ | 22.0 | 12.0 | 69.0 |
| Mar. | $1.33^{e}$ | $0^{d}$ | $0^{d}$ | $4^{cd}$ | $0^{c}$ | $5.33^{fg}$ | 25.4 | 16.6 | 62.0 |
| Apr. | $6.33^{d}$ | $0^{d}$ | $0.66^{cd}$ | $1.66^{de}$ | $1^{bc}$ | $9.65^{efg}$ | 24.3 | 17.9 | 67.0 |
| May | $8.33^{bcd}$ | $0^{d}$ | 3.33 | $1^{de}$ | $1.33^{bc}$ | $13.99^{ef}$ | 27.8 | 15.5 | 58.3 |
| Jun. | $8.66^{bcd}$ | $0^{d}$ | $1^{bcd}$ | $1^{de}$ | $2.66^{bc}$ | $13.32^{ef}$ | 37.1 | 18.8 | 65.0 |
| Jul. | $12.33^{abc}$ | $13.3^{cd}$ | $3^{a}$ | $2.33^{de}$ | $5.66^{a}$ | $36.65^{d}$ | 38.2 | 22.4 | 63.0 |
| Aug. | $11.66^{bc}$ | $78.33^{b}$ | $1.66^{bc}$ | $5.66^{c}$ | $6^{a}$ | $103.31^{b}$ | 30.5 | 24.3 | 67.0 |
| Sept. | $16.66^{a}$ | $131.7^{a}$ | $1.33^{bcd}$ | $12.33^{a}$ | $8^{a}$ | $169.98^{a}$ | 39.4 | 27.4 | 65.3 |
| Oct. | $13^{ab}$ | $16.33^{c}$ | $3.66^{a}$ | $8.33^{b}$ | $6.33^{a}$ | $47.65^{c}$ | 34.6 | 22.9 | 69.0 |
| Nov. | $7.33^{cd}$ | $0^{d}$ | $2^{b}$ | $6^{c}$ | $3.33^{b}$ | $18.66^{e}$ | 35.0 | 20.4 | 59.6 |
| Dec. | $0^{e}$ | $0^{d}$ | $0^{d}$ | $2.66^{cde}$ | $1.33^{bc}$ | $3.99^{fg}$ | 23.6 | 24.4 | 59.2 |
| Total | $85.6^{B}$ | $239.6^{A}$ | $16.64^{D}$ | $45.3^{C}$ | $36.64^{C}$ | 423.86 | - | - | - |
| $LSD_{5\%}$ | 3.70 | 8.55 | 0.88 | 2.65 | 2.41 | 10.25 | - | - | - |

$LSD_{5\%}$ for mite species = 15.2
Means in each column or row followed by the same letter (s) are not significantly different at 5% level.

Statistical analysis of data in Table (3) indicated that there were significant differences in total number of phytophagous mites infested Naval orange leaves along 2016 season, where there were significant differences between September (139.31) and other months ($LSD_{5\%}$ =7.2). Furthermore, there were significant differences in total number of *Ph. oleivora* (290.31) and other species ($LSD_{5\%}$ =8.55).

**Survey and population density of phytophagous mites associated with Balady orange:**

Considering the abundance of phytophagous mites on Balady orange all over the inspection periods, the numbers were varied according to the sampling dates (Table 4). The total numbers of collected mites were respectively 85.63, 239.6, 16.64, 45.3 and 36.64 indiv./10 leaves for *P. citri*, *P. oleivora*, *E. orientalis*, *B. californicus* and *T. californicus*. On the other hand, the highest population was noticed for all collected mites during September (169.98 indiv.), while during February there is not any phytophagous abundance. The lowest numbers of phytophagous mite population was observed during January and February (1.0 and 0.33 indiv., respectively), while the highest numbers of *P citri* and *B. californicus* were recorded on Balady orange (85.63 and 45.3 indiv., respectively).

Statistical analysis of data in Table (4) indicated that there were significant differences in total number of phytophagous mites infested Balady orange leaves along 2016 season, where there were significant differences between September (169.98) and other months (LSD5% =10.25). Furthermore, there were significant differences in total number of *Ph. oleivora* (239.6) and other species ($LSD_{5\%}$ =15.2).

From the obtained results in Tables (1–4), it could be noticed that Navel orange was more infested with *P. oleivora* than other citrus varieties (290.31 mite indiv.), also the lowest numbers of phytophagous mites infesting citrus trees was recorded on December, January and February, thus, this is the best time to apply different biological control programs .

**Survey and monthly population density of predacious mites associated with citrus varieties:**

As shown in Table (5) the predacious mites: *Amblyseius swirskii* Athias-Henriot (Phytoseiidae) and *Agistemus exsertus* González (Stigmaeidae) appeared in most of sampling dates with different numbers reaching their highest peak during August (2.33 and 3.66 indiv. on Balady mandarin, 4.33 and 2.66 indiv. on Valencia orange, 4.0 and 2.66 indiv. on Navel orange and 1.33 and 2.33 indiv. on Balady orange.

On the other hand, the total population of *A. swirskii* and *A. exsertus* all over the year recorded 9.63 and 20.64 indiv. on Balady mandarin, 19.31 and 12.98 indiv. on Valencia orange, 19.97 and 5.98 indiv. on Navel orange and 14.63 and 9.32 indiv. on Balady orange.

Generally, the population fluctuation of predacious mites on citrus varieties at Shenofa region during the period of study varied according to the infested hosts and sampling dates reaching its highest peak during August. The simple correlation values (r) helping in detecting any apparent relationship between population dynamics of phytophagous and predacious mites and each of the tested environmental conditions. Data in Table (6) indicated that the maximum & minimum temperature and relative humidity expressed as an insignificantly positive during 2016 season on population of *P. oleivora*, *E. orientalis*, *B. californicus*, *T. californicus*, *A. swirskii* and *A. exs*ertus, but high significantly difference was obtained between population of *P. citri* only. The average of these factors during the period of study was optimal for the activity of the different collected mites and therefore, did not produce a pronounced effect.

The obtained results are in harmony with those of Zheng *et al*. (2002) who showed that the decline of population of citrus red mite before autumn is due to high mortality of adult females that fed pear leaves and low hatch rate of the eggs produced by those females. In addition, Yassin (2004) recorded several predatory mites of numerous families as *A. swirskii*, *Typhlodromus* (*T.*) *pyri* Scheuten (Phytoseiidae) and *A. exsertus* (Stigmaeidae) to be the most abundant predatory species inhabiting leaves of mandarin, lime and orange, while *Cheletogenes ornatus* (Canestrini and Fanzago) and *Hemicheyletia bakeri* (Ehara) (Cheyletidae) were observed mostly on the fruits. The tydeid mites, *Orthotydeus californicus* (Banks), *O. kochi* (Oudemans) and *Pronematus ubiquitous* (McGregor) were observed on citrus leaves at Menoufia governorate during the early May, 1998 and 1999, then the mites increased gradually reaching the maximum level during early of October of the two seasons.

Karmaker and Saha (2005) observed significant correlations between population densities of *B. phoenicis* and meteorological factors such as temperature and precipitation.

Ledesma *et al*. (2011) reported that the phenology of *E. orientalis* took place in autumn which in agreement with second peak of the predator, *Euseius stipulates* (Athias-Henriot). An effect of *E. stipulatus*

Table (5): Average numbers of predacious mites/10 leaves on different citrus varieties during 2016 season

| Month | Average numbers of predacious mites/10 leaves | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Balady Mandarin | | Valencia orange | | Navel orange | | Balady orange | |
| | *A. swirskii* | *A. exsertus* | *A. swirskii* | *A. Exsertus* | *A. swirskii* | *A. exsertus* | *A. swirskii* | *A. exsertus* |
| Jan. | $0^{c}$ | $0^{d}$ | $0^{d}$ | $0^{d}$ | $0.33^{e}$ | $0^{d}$ | $0.33^{de}$ | $0^{d}$ |
| Feb. | $0^{c}$ | $1^{cd}$ | $1.66^{bc}$ | $0^{d}$ | $0^{e}$ | $0^{d}$ | $0^{e}$ | $0^{d}$ |
| Mar. | $0.33^{c}$ | 2.33 | $2.33^{b}$ | $1^{d}$ | $0.66^{e}$ | $1.33^{b}$ | $0.66^{de}$ | $0.33^{d}$ |
| Apr. | $0^{c}$ | $1.66^{cd}$ | $0^{d}$ | $1.66^{c}$ | $0^{e}$ | $0.66^{cd}$ | $0.33^{de}$ | $1^{cd}$ |
| May | $0.33^{c}$ | $3.33^{ab}$ | $1^{cd}$ | 2.33 | $0.33^{e}$ | $0^{d}$ | $0.66^{de}$ | 1.66 |
| Jun. | $0.66^{bc}$ | $2^{c}$ | $4^{a}$ | $0^{d}$ | $1^{de}$ | $0^{d}$ | $0.33^{de}$ | $0^{d}$ |
| Jul. | $0.33^{c}$ | $1^{cd}$ | $3.66^{a}$ | $0^{d}$ | $2.33^{cd}$ | $0^{d}$ | $0.33^{de}$ | $0^{d}$ |
| Aug. | $2.33^{a}$ | $3.66^{ab}$ | $4.33^{a}$ | $2.66^{ab}$ | $4^{b}$ | $2.66^{a}$ | $1.33^{cde}$ | $2.33^{b}$ |
| Sept. | $1.66^{ab}$ | $4.33^{a}$ | $1^{cd}$ | $3^{a}$ | $5.66^{a}$ | $1^{bc}$ | $2^{c}$ | $3.33^{a}$ |
| Oct. | $0.66^{bc}$ | $1.33^{cd}$ | $1.33^{bcd}$ | $2^{bc}$ | $1.66^{de}$ | $0.33^{cd}$ | $4.66^{a}$ | $0.33^{d}$ |
| Nov. | $1.33^{ab}$ | $0^{d}$ | $0^{d}$ | $0.33^{d}$ | $3^{bc}$ | $0^{d}$ | $3^{b}$ | 1c$^{d}$ |
| Dec. | $2^{a}$ | $0^{d}$ | $0^{d}$ | $0^{d}$ | $1.33^{de}$ | $0^{d}$ | $1.66^{cd}$ | $0^{d}$ |
| Total | $9.63^{D}$ | $20.64^{A}$ | $19.31^{A}$ | $12.98^{C}$ | $19.97^{A}$ | $5.98^{E}$ | $14.63^{B}$ | $9.32^{D}$ |
| $LSD_{5\%}$ | 0.78 | 1.09 | 0.89 | 0.64 | 1.09 | 0.53 | 1.03 | 0.98 |

$LSD_{5\%}$ for mites on citrus varieties = 1.58

Means in each column or row followed by the same letter (s) are not significantly different at 5% level

Table (6): Effect of environmental conditions on mite numbers associated with citrus leaves at Menoufia governorate during 2016 season

| Mite species | Envir. condo | Corr. ( r) | slope | $LSD_{5\%}$ | *P.* |
|---|---|---|---|---|---|
| *Panonychus citri* | Max. ºC | 0.576 | 0.92 | 2.9178 | $0.0043^{**}$ |
| | Min. ºC | 0.340 | 0.387 | | |
| | R.H. % | 0.035 | 0.031 | | |
| *Phyllocoptruta oleivora* | Max. ºC | 0.464 | 0.091 | 26.9837 | $0.5850^{ns}$ |
| | Min. ºC | 0.544 | 0.076 | | |
| | R.H. % | 0.275 | 0.031 | | |
| *Eutetranychus orientalis* | Max. ºC | 0.486 | 2.870 | 0.8469 | $0.0698^{ns}$ |
| | Min. ºC | 0.421 | 1.767 | | |
| | R.H. % | 0.140 | 0.471 | | |
| *Brevipalpus californicus* | Max. ºC | 0.469 | 1.104 | 2.256 | $0.6267^{ns}$ |
| | Min. ºC | 0.495 | 0.829 | | |
| | R.H. % | 0.172 | 0.230 | | |
| *Tydeus californicus* | Max. ºC | 0.728 | 1.709 | 2.281 | $0.7974^{ns}$ |
| | Min. ºC | 0.650 | 1.085 | | |
| | R.H. % | 0.186 | 0.248 | | |
| *Amblyseius swirskii* | Max. ºC | 0.477 | 2.082 | 1.2096 | $0.5259^{ns}$ |
| | Min. ºC | 0.549 | 1.707 | | |
| | R.H. % | 0.068 | 0.170 | | |
| *Agistemus exsertus* | Max. ºC | 0.233 | 1.225 | 0.9577 | $0.0840^{ns}$ |
| | Min. ºC | 0.319 | 1.1915 | | |
| | R.H. % | 0.109 | 0.325 | | |

$^{**}$ = significant ns = non-significant

on *E. orientalis* is probably happening, but abiotic variables are also affecting the populations of this mite pest.

Silva *et al.* (2012) studied the diversity of mites and population dynamics attacking *Citrus sinensis* in São Paulo, Brazil and found significant correlations between population densities of these mites and meteorological factors such as temperature and precipitation, in addition, *Euseius concordis* (Chant) acts as a natural enemy of *P. citri, B. phoenicis* and *P. oleivora* in the citrus orchard.

Barbar (2014) studied the bio-ecological aspects of phytoseiid and tetranychid mites in Syrian citrus orchard conditions as a dominant species on citrus leaves and seemed to have different population dynamics, different overwintering sites and phenology in winter, apparently due to differences in climatic requirements.

Abu Bakar (2015) reported that abiotic factors affect mites' population, and gave a pattern to manage the mites on citrus at the required time and season. Also in 2016 he found that the relative humidity and rainfall showed significantly negative correlation to population of *E. orientalis*.

Ata *et al.* (2016) studied population dynamic of mite species inhabiting leaves and debris of navel orange and mandarin, at Fayoum governorate, with relation of biotic factors (predator mites) and a biotic factor (temperature and relative humidity).

Our results are in parallel with those of Abdelgayed *et al*. (2015, 2017) who studied the occurrence of phytophagous and predatory mites inhabiting citrus trees at Assuit governorate (Upper Egypt) and found *E. orientalis*, *B. phoenicis* and *Polyphagotarsonemus latus* (Banks) (Tarsonemidae) seemed to be the most common phytophagous species found in citrus orchards.

From the obtained results, it could be reported that winter months are suitable for releasing and applying different bio-agents including predatory mites where the pests are lowest in numbers as well as the optimum environmental factors are present.

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