



**POPULATION FLUCTUATIONS OF IMMATURE STAGES OF THE CITRUS  
FLOWER MOTH, *PRAYS CITRI* MILL. (LEP.: HYPONOMEUTIDAE)  
ON LIME TREES**

**[147]**

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**ABSTRACT**

Mean numbers of immature stages of *Prays citri* Mill. on lime flower buds showed six annual population peaks of 13.3, 1.2, 1.8, 6.2, 2.8 and 3.4 in mid-May, mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively during 2015/2016 season. Five peaks of 13.5, 14.5, 1.8, 5.8 and 5.0 immature stages were observed on flowers in mid-Apr., mid-June, mid-Oct., mid-Dec. and mid-Mar., respectively. On newly formed fruits, five peaks of 7.3, 0.4, 2.2, 1.8 and 2.4 immature stages were also recorded in the middle of June, Oct., Dec., Feb. and Mar., respectively. The general mean was the highest (11.3 immature stages) in June, while it was the lowest (0.0 immature stage) in Sep. The highest population density of *P. citri* was recorded in spring, followed by summer then winter and autumn. The seasonal mean was 4.1 immature stages in 2015/2016 season.

The same trend could be applied during 2016/2017 season. Six peaks of 12.8, 2.5, 4.0, 5.8, 3.3 and 4.6 immature stages were estimated on lime flower buds in mid-May, mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. Mean numbers of *P. citri* immature stages on flowers also exhibited six peaks of 14.5, 2.8, 5.3, 7.2, 4.3 and 5.6 in mid-Apr., mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. Six peaks of 5.8, 1.0, 1.8, 3.0, 1.5 and 2.4 immature stages were also found on newly formed fruits in the middle of May, Oct., Nov., Dec., Feb. and Mar., respectively. The highest general mean was 10.8 immature stages in May, while the lowest was 0.0

immature stage in Sep. The highest population density of *P. citri* occurred in spring, followed by summer then winter and autumn. The seasonal mean was 4.6 immature stages in the second season.

**INTRODUCTION**

*P. citri* is an economically important pest infesting different species and varieties of citrus in several continents (Anonymous, 1982; Silva et al 2006; Toth et al 2009; Conti and Fisticaro, 2015). Lime, lemon, sweet orange and navel orange were more susceptible host plants to the pest infestation, while grapefruit, sour orange and mandarin were more resistant ones (Shehata, 1982; Ibrahim and Shahateh, 1984; Abo-Sheaasha, 1987 and 1994; Abd El-Kareim et al 2017). Volatile oils in citrus flowers contain different chemical compounds having odors, which stimulate or inhibit females to lay eggs on susceptible or resistant plants, respectively (El-Sayed et al 1994).

In Egypt, Abd El-Kader and Zaklama (1967) first recorded existence of *P. citri* on lime flowers in Alexandria Governorate. Afterwards, this pest infested many other citrus trees in several Governorates of the Nile Delta (Shehata, 1982; Abo-Sheaasha, 1987; Abd El-Kareim et al 2017). *P. citri* had nine annual generations on lime trees (Abd El-Kader and Zaklama, 1967; Abo-Sheaasha, 1987). However, it had 11 generations a year on lime trees (Shehata, 1982).

*P. citri* larvae feed on flower buds, flowers, newly formed fruits, leaves and shoots of lemon and lime trees (Liotta and Mineo, 1962; Shehata, 1982; Abo-Sheaasha, 1987; Mineo, 1993; Carimi et al 2000; EFSA, 2008). The larvae preferably

feed on reproductive organs and interior petals of lemon flowers. They also attack mesocarps and seeds of newly formed fruits causing premature fruit dropping (Liotta and Mineo, 1962). *P. citri* larvae bore beneath rinds of different citrus fruits forming galls, which remain open at tips for destructively invasive fungi (Garcia, 1939). The heavy infestation of *P. citri* caused 30-40% loss of citron crop (Talhouk, 1969; Perez-Ibaniz et al 1973). *P. citri* infestation was over 50% on flowers and fruits of lemon, but it reached 100% on flowers in May and June (Mineo et al 1980).

Seasonal changes of *P. citri* larvae were investigated on lime trees in Egypt (Shehata, 1982; Abo-Sheasha, 1987). The present work aimed to study population fluctuations of immature stages of this pest on lime trees for better timing of control tactics.

#### MATERIALS AND METHODS

Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits were estimated at ElKanater ElKhairia region, ElQalubia Governorate throughout two successive seasons from 9 April, 2015 to 30 March, 2017.

A lime orchard of half feddan was selected for sampling. Trees were monthly sprayed with different insecticides to control insect pests including *P. citri* for maintaining high production of lime fruits. Weekly samples of 50 flower buds, 50 flowers and 50 newly formed fruits were collected randomly from lime trees. These samples were placed separately in plastic bags and transferred to the laboratory, where they were examined carefully under a stereomicroscope. Numbers of eggs, larvae and pupae of *P. citri* on tree parts were counted and recorded.

The analysis of variance (ANOVA / F test) was used to analyse the variance among insect stages, tree parts and season months. L.S.D. test was applied to compare among means of treatments. The simple correlation was computed to show the relationship between mean numbers of immature stages and daily means of temperatures or relative humidities throughout the two seasons.

#### RESULTS AND DISCUSSION

Population fluctuations of *P. citri* immature stages were calculated monthly and expressed as mean numbers of eggs, larvae and pupae. Results obtained are presented in Tables 1, 2 and graphically illustrated in Figs. 1, 2.

#### 1- The first season (2015-2016)

The seasonal abundance of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits fluctuated throughout successive counts during 2015/2016 season (Table 1 and Fig. 1). Mean numbers of immature stages on flower buds showed six population peaks of 13.3, 1.2, 1.8, 6.2, 2.8 and 3.4 in mid-May, mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. On lime flowers, five peaks of 13.5, 14.5, 1.8, 5.8 and 5.0 immature stages were observed in mid-Apr., mid-June, mid-Oct., mid-Dec. and mid-Mar., respectively. Five peaks of 7.3, 0.4, 2.2, 1.8 and 2.4 immature stages were also recorded on newly formed fruits in mid-June, mid-Oct., mid-Dec., mid-Feb. and mid-Mar., respectively. The general mean was the highest (11.3 immature stages) in June, while it was the lowest (0.0 immature stage) in Sep. The highest population density of *P. citri* occurred in spring, followed by summer then winter and autumn. The seasonal mean was 4.1 immature stages in the first season.

#### 2- The second season (2016-2017)

Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits continued throughout subsequent records during 2016/2017 season (Table 2 and Fig. 2). On flower buds, six peaks of 12.8, 2.5, 4.0, 5.8, 3.3 and 4.6 immature stages were recorded in mid-May, mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. Mean numbers of immature stages on lime flowers also showed six peaks of 14.5, 2.8, 5.3, 7.2, 4.3 and 5.6 in mid-Apr., mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. Six peaks of 5.8, 1.0, 1.8, 3.0, 1.5 and 2.4 immature stages were also found on newly formed fruits in mid-May, mid-Oct., mid-Nov., mid-Dec., mid-Feb. and mid-Mar., respectively. The highest general mean was 10.8 immature stages in May, while the lowest was 0.0 immature stage in Sep. The highest population density of *P. citri* occurred in spring, followed by summer then winter and autumn. The seasonal mean was 4.6 immature stages in the second season.

F test showed that there were highly significant differences among insect stages, tree parts and season months of the two years. Moreover, the correlation was insignificantly positive between mean numbers of immature stages and the temperature. However, it was highly significantly negative regarding the relative humidity.

**Table 1.** Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits at ElKanater ElKhairia region, ElQalubia Governorate during 2015/2016 season

Sampling date	Mean n. of eggs			Mean n. of larvae			Mean n. of pupae			Mean n. of immature stages			General mean	
	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits		Total
Apr.2015	2.8±0.5	2.5±1.3	1.5±0.7	5.3±0.9	8.5±1.6	3.5±1.5	1.3±0.3	2.5±0.7	0.3±0.3	9.3±0.5	13.5±2.3	5.3±1.7	28.1	9.4±1.2
May	7.8±0.5	4.5±1.1	3.3±0.5	4.8±1.4	6.3±0.3	1.8±0.3	0.8±0.5	1.8±0.9	0.3±0.3	13.3±1.7	12.5±0.9	5.3±0.8	31.1	10.4±0.8
Jun.	7.3±1.8	7.3±0.9	4.5±0.9	4.8±1.1	6.0±1.1	2.8±0.8	0.3±0.3	1.3±0.5	0.0±0.0	12.3±2.8	14.5±2.4	7.3±3.7	34.1	11.3±2.2
Jul.	2.0±0.3	2.2±0.2	0.8±0.2	1.0±0.0	1.8±0.2	0.2±0.2	0.0±0.0	0.4±0.2	0.0±0.0	3.0±0.3	4.4±0.5	1.0±0.3	8.4	2.8±0.2
Aug.	0.5±0.3	0.5±0.3	0.0±0.0	0.0±0.0	0.5±0.3	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.5±0.3	1.0±0.6	0.0±0.0	1.5	0.5±0.3
Sep.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0	0.0±0.0
Oct.	0.8±0.5	1.0±0.4	0.2±0.2	0.4±0.2	0.8±0.5	0.2±0.2	0.0±0.0	0.0±0.0	0.0±0.0	1.2±0.7	1.8±0.9	0.4±0.2	3.4	1.1±0.6
Nov.	1.0±0.6	0.3±0.3	0.3±0.3	0.8±0.8	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	1.8±1.5	0.3±0.3	0.3±0.3	2.4	0.8±0.7
Dec.	3.2±0.2	3.2±0.2	1.2±0.2	2.8±0.2	2.6±0.3	1.0±0.4	0.2±0.2	0.0±0.0	0.0±0.0	6.2±0.4	5.8±0.4	2.2±0.4	14.2	4.7±0.3
Jan.2016	1.0±0.4	1.5±0.7	0.5±0.3	0.5±0.3	1.3±0.5	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	1.5±0.7	2.8±1.1	0.5±0.3	4.8	1.6±0.6
Feb.	2.8±0.7	2.0±0.4	1.5±0.5	0.0±0.0	1.0±0.0	0.3±0.3	0.0±0.0	0.0±0.0	0.0±0.0	2.8±0.7	3.0±0.4	1.8±0.7	7.6	2.5±0.6
Mar.	2.4±0.3	2.6±0.3	1.8±0.2	1.0±0.3	2.4±0.4	0.6±0.2	0.0±0.0	0.0±0.0	0.0±0.0	3.4±0.2	5.0±0.3	2.4±0.4	10.8	3.6±0.2
Total	31.6	27.6	15.6	21.4	31.2	10.4	2.6	6.0	0.6	55.3	64.6	26.5	146.4	
General Mean	2.6±1.1	2.3±0.6	1.3±0.4	1.8±0.6	2.6±0.8	0.9±0.3	0.2±0.1	0.5±0.3	0.1±0.0	4.6±1.3	5.4±1.5	2.2±0.7	12.2	4.1±1.1
F value for insect stages = 47.77** L.S.D. at 0.05p = 0.62														
Eggs. F value for			Larvae. F value for			Pupae. F value for			Immature stages. F value for			L.S.D. at		
L.S.D. at 0.05p = 0.43			L.S.D. at 0.05p = 0.44			L.S.D. at 0.05p = 0.17			L.S.D. at 0.05p = 0.17			L.S.D. at 0.05p = 0.75		
tree parts = 19.65**			tree parts = 29.97**			tree parts = 13.22**			tree parts = 37.99**					
season months = 36.43**			season months = 36.95**			season months = 11.90**			season months = 53.26**					
Eggs			Larvae			Pupae			Eggs			Immature stages		
r = 0.065			0.076			0.134			R.H. r = -0.535**			-0.409**		
												-0.578**		

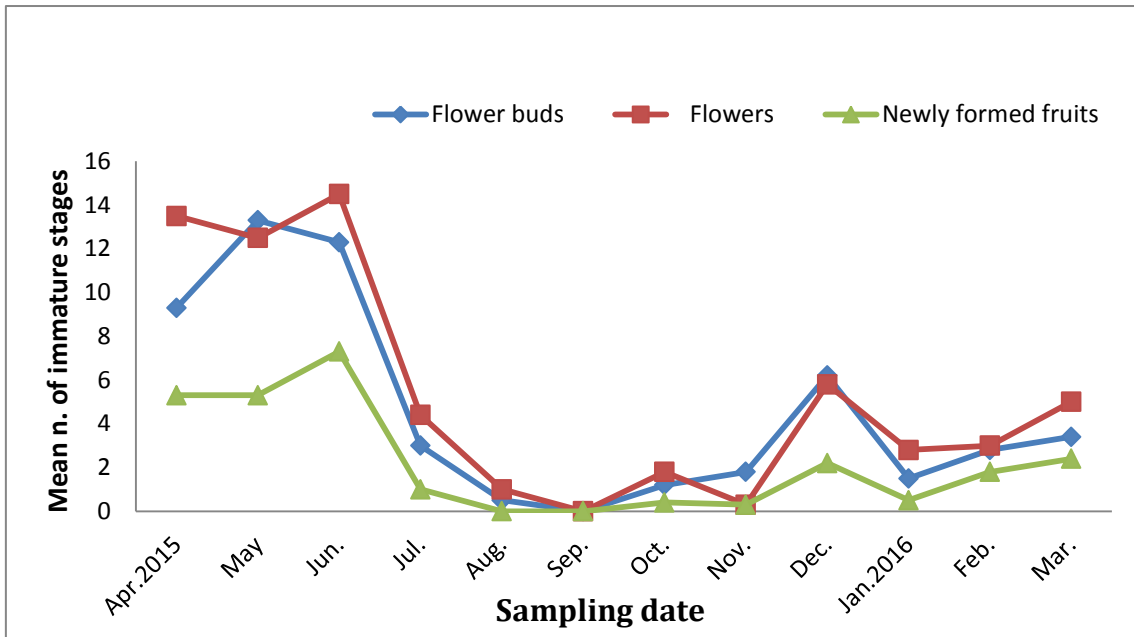


Fig. 1. Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits at ElKanater ElKhairia region, ElQalubia Governorate during 2015/2016 season

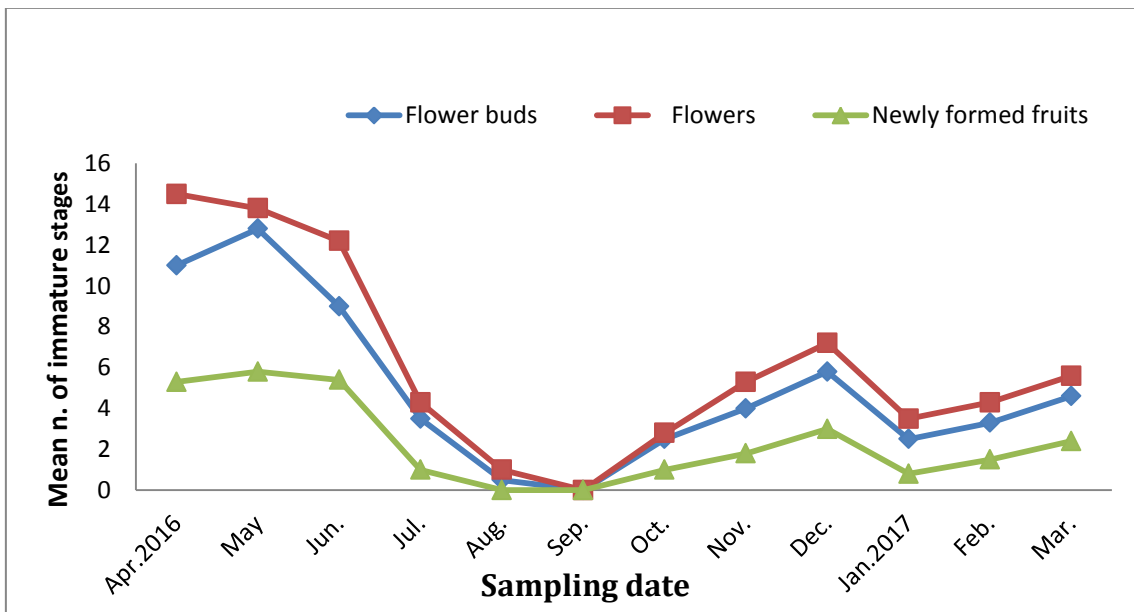


Fig. 2. Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits at ElKanater ElKhairia region, ElQalubia Governorate during 2016/2017 season.

**Table 2.** Population fluctuations of *P. citri* immature stages on lime flower buds, flowers and newly formed fruits at EIkhanter EIkhairia region, ElQalubia Governorate during 2016/2017 season

Sampling date	Mean n. of eggs			Mean n. of larvae			Mean n. of pupae			Mean n. of immature stages			Total	General mean
	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits	Flower buds	Flowers	Newly formed fruits		
Apr.2016	5.3±1.0	6.0 ±1.1	2.5±0.6	5.3±0.6	7.5±0.6	3.3±0.8	0.5±0.3	1.5±0.3	0.0±0.0	11.0±1.7	14.5±0.6	5.3±0.9	30.8	10.3±0.9
May	7.3±0.3	6.3±0.5	3.3±0.6	5.0±0.6	5.5±0.6	2.3±0.6	0.5±0.3	2.0±0.4	0.3±0.3	12.8±0.2	13.8±0.3	5.8±0.8	32.3	10.8±0.3
Jun.	4.4±0.6	5.0±0.9	2.6±0.2	4.4±0.8	5.6±0.9	2.6±0.6	0.2±0.2	1.6±0.2	0.2±0.2	9.0±1.3	12.2±1.9	5.4±0.9	26.6	8.9±1.3
Jul.	1.8±0.3	1.8±0.3	0.8±0.3	1.5±0.3	1.8±0.3	0.3±0.3	0.3±0.3	0.8±0.3	0.0±0.0	3.5±0.6	4.3±0.5	1.0±0.4	8.8	2.9±0.5
Aug.	0.5±0.3	0.5±0.3	0.0±0.0	0.0±0.0	0.5±0.3	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.5±0.3	1.0±0.6	0.0±0.0	4.0	1.4±0.5
Sep.	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0	0.0±0.0
Oct.	1.5±0.5	1.3±0.5	0.8±0.3	1.0±0.4	1.5±0.5	0.3±0.3	0.0±0.0	0.0±0.0	0.0±0.0	2.5±0.9	2.8±0.9	1.0±0.4	6.3	2.1±0.7
Nov.	2.3±0.3	1.5±0.3	1.3±0.3	1.8±0.3	2.5±0.3	0.5±0.3	0.0±0.0	1.3±0.3	0.0±0.0	4.0±0.4	5.3±0.5	1.8±0.5	11.0	3.7±0.4
Dec.	3.2±0.4	2.2±0.2	1.8±0.2	2.6±0.2	3.0±0.3	1.2±0.2	0.0±0.0	2.0±0.3	0.0±0.0	5.8±0.5	7.2±0.6	3.0±0.3	16.0	5.3±0.4
Jan.2017	1.5±0.3	1.5±0.3	0.5±0.3	1.0±0.4	1.3±0.3	0.3±0.3	0.0±0.0	0.8±0.5	0.0±0.0	2.5±0.6	3.5±0.9	0.8±0.5	6.8	2.3±0.7
Feb.	2.0±0.4	2.3±0.5	1.0±0.4	0.8±0.3	1.5±0.3	0.5±0.3	0.5±0.3	0.5±0.3	0.0±0.0	3.3±0.3	4.3±0.9	1.5±0.6	9.0	3.0±0.5
Mar.	2.4±0.2	2.6±0.2	1.4±0.2	2.2±0.2	2.6±0.2	1.0±0.3	0.0±0.0	0.4±0.2	0.0±0.0	4.6±0.2	5.6±0.2	2.4±0.2	12.6	4.2±0.1
Total	32.2	31.0	16.0	25.6	33.3	12.3	2.0	10.9	0.5	59.5	74.5	28.0	164.2	46.6±1.0
General Mean	2.7±0.6	2.6±0.6	1.3±0.3	2.1±0.5	2.7±0.3	1.0±0.3	0.2±0.1	0.9±0.2	0.1±0.0	5.0±0.6	6.3±0.8	2.3±0.6	13.7	4.6±1.0

F value for insect stages = 72.69* L.S.D. at 0.05p = 0.56											
Eggs.	F value for	L.S.D. at 0.05p	Larvae.	F value for	L.S.D. at 0.05p	Pupae.	F value for	L.S.D. at 0.05p	Immature stages.	F value for	L.S.D. at 0.05p
	= 34.10**	= 0.36	tree parts = 53.67**	= 0.34	tree parts = 70.77**	= 0.15	tree parts = 85.76**	= 0.75			
	season months = 41.40**	= 0.72	season months = 47.25**	= 0.69	season months = 7.96**	= 0.30	season months = 68.03**	= 1.51			
Eggs	Larvae	Larvae	Pupae	Immature stages	Eggs	Larvae	Pupae	Immature stages			
r = 0.039	0.074	-0.045	-0.046	R.H.	r = -0.459**	-0.469*	-0.205**	-0.469**			

Similar population trends were reported by **Abo-Sheaasha (1987)** who found that the population density of *P. citri* larvae was high on lime trees from late April to early July with an outstanding peak in late June and low larval population from January to March. Trends of larval population fluctuations were almost the same in 1983 and 1984. **Quayle (1938)** stated that *P. citri* larvae prevailed on lemon blossoms from April to November and peaked in mid-summer in Italy. **Buchelos et al (1963)** recorded a sudden increase in the population density of *P. citri* larvae on lemon flowers in late May. Subsequent generations of this pest continued to attack flowers of lemon and citron until next February. **Abd El-Kareim et al (2017)** indicated that larval and pupal populations together of *P. citri* on lime flowers exhibited one abundance peak of 2.5 and 2.2 individuals on 10 April, 2015 and 1 April, 2016, respectively. Two seasons of the flower sampling started from 20 February to 24 April. *P. citri* populations showed a positive response to the mean temperature, while they exhibited a negative correlation with the mean relative humidity.

On the other hand, **Shehata (1982)** reported that *P. citri* larvae occurred on lime trees all the year round. The larval population on flowers showed 10 peaks between April 1978 and January 1979. Three periods of the maximum larval population on fruits were recorded in mid-June, mid-July and late September of the two years, respectively. **Abo-Sheaasha (1987)** found that autumn was characterized with the highest abundance for *P. citri* larvae, followed by summer, spring and winter. **Bodenheimer (1951)** indicated that *P. citri* larvae occurred on flowers of citron and lemon in September and reached their maximum abundance from January to March in Palestine. **Mineo et al (1991)** showed that eggs and larvae of *P. citri* were found on lemon trees all the year round in Italy. They were more abundant in the 1<sup>st</sup> three weeks of January, from early May to mid-July and from late August to late December.

**Conclusion:** Based on the current data, control measures against *P. citri* on lime should be applied from late April to early May to deter adult females from laying eggs resulting in low pest infestation.

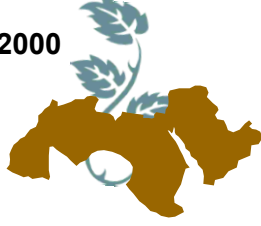
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تقلبات تعداد الأطوار غير البالغة لفراشة أزهار الحمضيات (الموالح)، بريز سيتري ميلل (رتبة الحشرات حرشفية الأجنحة: فصيلة هيونوميدي) على أشجار الليمون البلدي

[147]

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المتوسط الموسمي 4.1 أطوار غير بالغة خلال الموسم الأول.

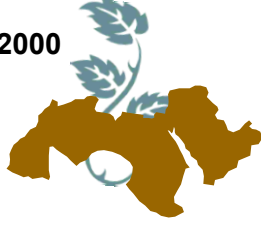
أمكن تطبيق نفس الإتجاه خلال موسم 2016/2017. أظهرت النتائج ستة ذروات هي 12.8، 2.5، 4.0، 5.8، 3.3، 4.6 أطوار غير بالغة على البراعم الزهرية في منتصف شهر مايو وأكتوبر ونوفمبر وديسمبر وفبراير ومارس على التوالي. كما أوضحت أيضاً الأعداد المتوسطة للأطوار غير البالغة على الأزهار ستة ذروات متوالية هي 14.5، 2.8، 5.3، 7.2، 4.3، 5.6 في منتصف شهر أبريل وأكتوبر ونوفمبر وديسمبر وفبراير ومارس. وجدت أيضاً ستة ذروات هي 5.8، 1.0، 1.8، 3.0، 1.5، 2.4 أطوار غير بالغة على الثمار الحديثة العقد في منتصف شهر مايو وأكتوبر ونوفمبر وديسمبر وفبراير ومارس على الترتيب. كان المتوسط العام هو الأعلى (10.8 أطوار غير بالغة) في مايو والأدنى (صفر) طور غير بالغ) في سبتمبر. حدثت أعلى كثافة عددية للحشرة في فصل الربيع يليه الصيف ثم الشتاء والخريف. كان المتوسط الموسمي 4.6 أطوار غير بالغة في الموسم الثاني.

الكلمات الدالة: فراشة أزهار الموالح، تقلبات التعداد، أشجار الليمون البلدي

### الموجز

تم تسجيل ستة ذروات عديدة لمتوسط أعداد الأطوار غير البالغة لفراشة أزهار الحمضيات (الموالح) على البراعم الزهرية للليمون البلدي هي 13.3، 1.2، 1.8، 6.2، 2.8، 3.4 في منتصف شهر مايو وأكتوبر ونوفمبر وديسمبر وفبراير ومارس على التوالي خلال موسم 2016/2015. لوحظت خمسة ذروات عديدة هي 13.5، 14.5، 1.8، 5.8، 5.0 أطوار غير بالغة على الأزهار في منتصف شهر أبريل ويونيو وأكتوبر وديسمبر ومارس على الترتيب. سجلت أيضاً على الثمار الحديثة العقد خمسة ذروات متوالية هي 7.3، 0.4، 2.2، 1.8، 2.4 أطوار غير بالغة في منتصف شهر يونيو وأكتوبر وديسمبر وفبراير ومارس. كان المتوسط العام هو الأعلى (11.3 أطوار غير بالغة) في يونيو والأدنى (صفر طور غير بالغ) في سبتمبر. سجلت أعلى كثافة عددية للحشرة في فصل الربيع يليه الصيف ثم الشتاء والخريف. كان

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