J. Agric. Sci. Mansoura Univ., 34 (6): 6843 - 6850, 2009

POPULATION DYNAMICS AND DISTRIBUTION OF THE CITRUS LEAF MINER, *Phyllocnistis citrella* STAINTON LARVAE ON DIFFERENT CITRUS SPECIES

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ABSTRACT

Ecological studies of citrus leaf miner (CLM), *P. citrella*. were carried out in citrus orchard at Faculty of Agriculture, Al-Azhar University. All citrus cultivars are variously attacked by such pest. This study was carried out on navel orange, lime and mandarin, through two successive years (2006 and 2007). The most susceptible species was navel orange and lime, while the least species was mandarin. The infestation in the two years, started in the first week of May, until the end of the first week October. The infestation in the second year (2007), was higher than the first (2006). In the first season (2006), the population was fluctuated and showed five to seven peaks. The highest peak on navel orange, lime and mandarin, was 192, 162, 73 insect /50 leaves respectively, in 30th of July. While in the second year (2007), the population also had five to seven peaks, the highest peak on navel orange, lime and mandarin, was 214, 192, 88 insect /50 leaves respectively, on 29th of July. In the first year (2006), all abiotic factors (daily max. temperature, daily min temp. and daily mean temp.) had a positive and highly significant effect. While relative humidity had a negative and insignificant effect, on population. The biotic factors (parasites) in the same season gave a positive and insignificant effect. In the second year (2007) daily max. temp., daily min temp. and daily mean temp. had a positive highly significant effect. The effect of relative humidity was a negative and insignificant, while the parasites had a positive and insignificant effect. The combined effect of all factors was 75.66 in 2006 and 65.66% in 2007. The population of CLM preferred the eastern and southern than the westren and northern directions of the trees.

Keywords: citrus leaf miner, *Phyllocnistis citrella***,** population dynamics, distribution.

INTRODUCTION

The citrus leaf miner (CLM), *P. citrella*. was simultaneously observed in most countries of the world (Heppner, 1993). Infestation was common in all citrus orchards and was abundant enough to cause serious damage. Citrus leaf miner larvae mine tender foliage and stems of citrus trees, killing leaf tissue and causing leaf drop (Knapp *et al.*, 1994). In Egypt, it was first discovered during the summer of 1994 at El-Sharkia and Ismalia Governorates. Before this date, this insect was not recorded in Egypt (Abdel-Aziz 1995) and Abo-Sheaesha, 1997). Then, it spread rapidly throughout most of the citrus growing areas. Its population had increased geometrically and within the last ten years, it became the most important pest of citrus in Egypt. The sour orange seemed to be the most susceptible. In addition, the following group (lime, orange and grape fruit) can be categorized as, moderate group, while the last species (mandarin), which represents less preferred one (El-Dessouki, *et al.*, 2005). Species belonging to genus citrus and related ones of the family Rutaceae, appear to be the principal host plants of *P. citrella*. Other hosts were mentioned in literature such as Jasmine, Mistletoe, some legumes and willow, but these hosts had not been observed. In Egypt,

little information is available on *P. citrella*. The aim of this investigation was to study the population dynamics, distribution, biotic and abiotic factors affect population activity.

MATERIALS AND METHODS

Weekly samples, each of fifty young leaves were chosen on five directions (East, West, North, South and Middle) ten leaves form each direction from three citrus species (navel orange, lime and nandarin) trees of about 25 years old to study the preference and population dynamics of *P. citrella.* The leaves of citrus species were examined on area of about 1/4 feddan for all species of the tested area in orchard of citrus during the two successive seasons (2006 and 2007) at Faculty of Agriculture, Al-Azhar University. The samples were collected in a plastic sac from leaves of citrus species, counted and examined in the laboratory for CLM, larvae and their parasitoids. To identfy and count the parasitoids, the leaves of each group were put singly in petri-dishs (15 cm. diam.) contain moist filter paper. The dishes were left under laboratory conditions and examined daily to record its parasitoids.

To estimate the effectiveness of abiotic factors (climatic factors) on the population dynamics of *P. citrella* during the two successive seasons (2006 and 2007), climatic factors were represented by daily mean max. temperature (in ºC), daily mean min. temp., daily mean temp., daily mean range temp. and daily mean relative humidity. Records of these factors were supplied by the Meteorological Administration, at Kobry El-Kobba, Cario.

The data were statistically analyzed by the aid of computer (Minitab program) to determine the infestation differences between the citrus species and to clearify the correlation and the effect of climatic factors and parasitoids on the population dynamics of *P. citrella*. and some data were analyzed by Duncan multiple range test and multiple F-test Duncan, (1955).

RESULTS AND DISCUSSION

1. Population dynamics of *P. citrella* larvae on three citrus species.

Data given in Figure (1, A and B) show the population fluctuations of *P. citrella* larvae expressed as total number of larvae per 50 leaves through two successive years (2006 and 2007). The obtained data revealed that the total number of larvae collected from navel orange, lime and mandarin) in 2007 was relatively higher than that in 2006. The infestation in the two seasons, started in the first week of May, until the end of first week of October. In the first season (2006), the population flactuated up and down to record five to seven peaks of infestation and the highest peak on navel orange, lime and mandarin, was 192, 162, 73 insect /50 leaves respectively, on 30th of July. While in the second year (2007), the population also had five to seven peaks and the highest peak on navel orange, lime and mandarin, was 214, 192, 88 insect /50 leaves, respectively, on 29th of July.

During such course of investigation, it is clear that the citrus leaf miner preferred some citrus species than others. Such phenomenon could be coincide the numbers of detected larvae, through such period of research

work. As shown in Figure (1, A and B) the citrus species are presented in descending order, according to the relative preference of *P. citrella*. The navel orange was the most preferrable species for CLM, infestation and it·s the most susceptible species compared with other citrus species throughout the two successive years. Lime species ranked second, while mandarin species was the least susceptible one.

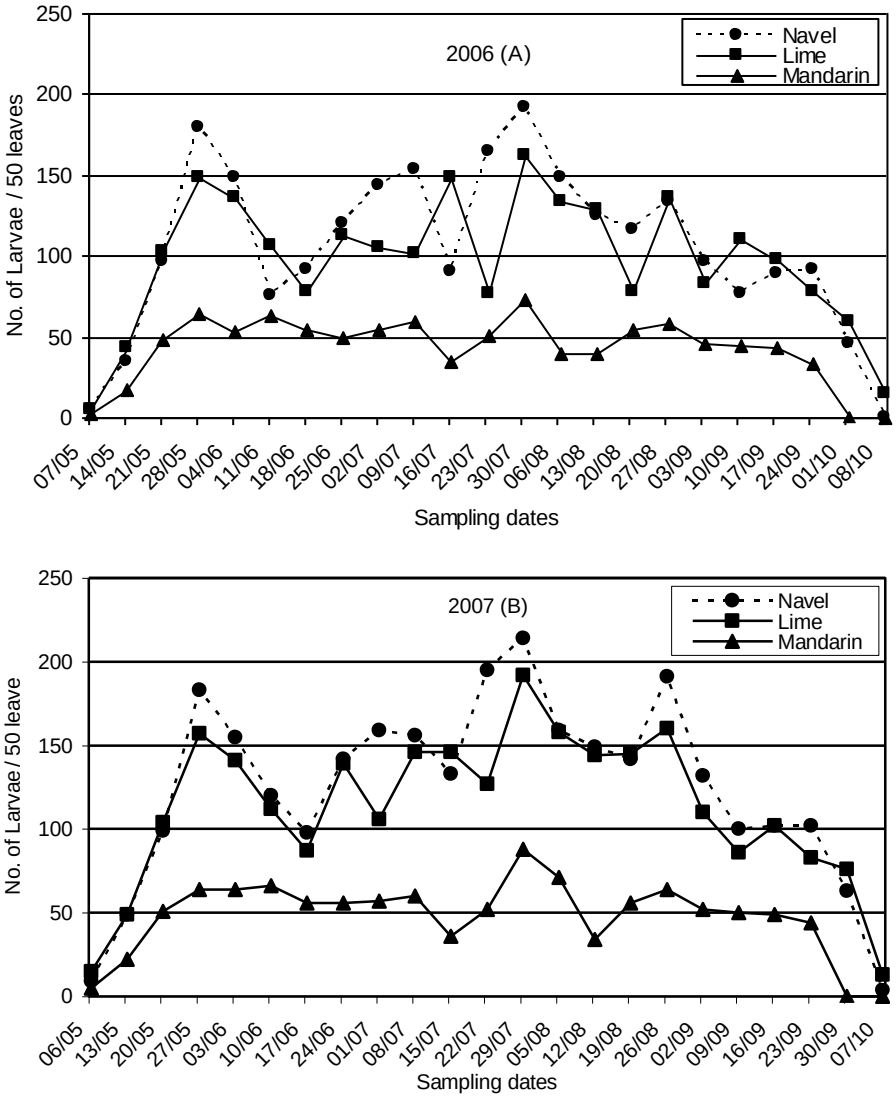


Figure (1): Weekly total numbers of *P. citrella* larvae/50 leaves of three citrus species at citrus orchard, at Faculty of Agriculture Al-Azhar University, during the two seasons, of 2006 (A), and 2007 (B).

Such observations may be assured by those data found by Pena *et al.*, (1996) who found that high peaks of populations were observed during summer (June-July) and in fall (September-October) in Florida. The results obtained by Abdel-Aziz (1996) on some species of citrus (sour orange, lime and mandarine) during the period from November 1994 to October 1995, showed that the infestation started in a low rate in late March and increased gradually during April, reaching its main peak by June. Then it decreased sharply in July and began to increase again in August. A minor peak occurred in September, followed by a decrease again in October, this result differed from our observations which may be due to differences in the weather factors in the area or the age of the trees in Egypt. While Abo-Sheaesha (1997), studied the population size of larval infestation which was comparatively higher during 1995 than in 1996. Also, El Saadany, et. al. (2002), found that CLM, infestation started to appear in new shoots as early as Mid April, 1996 and 1st week of May for both 1997 and 1998 at Qalyoubia Governorate. The CLM, infestation disappeared during the 1st half of December. Seven field generations were completed during citrus flushing periods. At Shrkia Governorate, the main period of activity extended between the 2nd week of May and the last week of December, thus demonstrating nine generations. At Beni-Sweif Governorate, however, young citrus trees harbored the infestation high figures and revealed possibly all the year round and 10 annual generations were recorded on navel orange. The navel orange was the most preferrable species for citrus CLM, infestation and the most susceptible compared with other citrus varieties throughout the three successive years. Lime variety ranked second, while mandarin variety was the least. All above authors indicated that the resistance is partly dependant on leaf size, as larger leaves seem to be more susceptible to attack. Less wax and larger numbers of stomatal openings on leaves may also make it more susceptible. The results obtained by Abdel-Rhman, (2005), on citrus leaf miner *P. citrella* had five to eight peaks a yearlly on citrus trees. Generally, summer season was considered the richest season of *P. citrella* larvae abundance, followed by either autumn or end of spring seasons in the insect population.

2. Effect of biotic and abiotic factors on the population activity.

Data presented in Table (1) showed the simple correlation and partial regression values for abiotic factors, which were represented for (daily mean max. temperature (in ºC), daily mean min. temp., daily mean temp., and daily mean relative humidity). While the biotic factors involved the parasitoids which included eulphid, *Pnigalio* sp. a primary ectoparasitoid and *Cirrosplius* sp. endoparasitoid which affected the population density of the insect on three species; navel orange, lime and mandarin trees.

The data showed that all the abiotic factors were positively and highly significant. While daily relative humidity had a negative and insignificant on population during the first year 2006, this means that all these factors were within the optimal range for population activity. In the same year, the biotic factors were positively correlated and insignificant, these mean that the biotic factors were above the level of optimum for population activity. In addition, the second year 2007, daily mean max. temperature, daily min temp. and daily

mean temp. had a positive and highly significant effect. Relative humidity was negative and insignificant. This mean that all these factors were within the optimal range for population activity. While biotic factors were positive and insignificant, on *P. citrella*. These factors were above the optimum level of population activity. The combined effect of all factors gave 75.66 % in 2006 and 65.66 % in 2007.

Table (1): Simple correlation and Partial regression values of five biotic and abiotic factors with their variability and probability levels of the population dynamics of *P. citrella* larvae on three citrus species at citrus orchard, Faculty of Agriculture Al-Azhar University during two seasons of 2006 and 2007.

Year	Source of variation	Simple correlation		Partial regression		"F" value		E.V.%
		r	P	b	p	f	p	
2006	Daily max. temp.	0.689	0.000	8.722	0.135			
	Daily min. temp.	0.560	0.000	0.365	0.963			
	Daily mean temp.	0.659	0.000	-0.529	0.841			
	Relative humidity	-0.272	0.108	-2.678	0.053	8.99	0.001	75.66
	Parasitoids No.	0.280	0.641	3.548	0.002			
2007	Daily max. temp.	0.701	0.000	14.360	0.027			
	Daily min. temp.	0.527	0.002	-6.100	0.553			
	Daily mean temp.	0.642	0.000	-2.579	0.781			
	Relative humidity	-0.227	0.443	-0.552	0.824	5.11	0.001	65.66
	Parasitoids No.	0.296	0.471	2.662	0.057			

r: Simple correlation coefficient value. **P: Probability level.**
b: Partial regression coefficient value. **E.V.: Explained variance.**

Such observations may be assured by those were detected by Bagmare *et. al*.,(1995) in India, who found that the mean temperature and sunshine hours had a positive correlation with the population of *P. citrella*. While Abo-Sheaesha (1997) in Egypt, mentioned that the weather factors particularly temperatures play an important role in the development of *P. citrella*. There is a highly significant positive relation between daily mean temperature and larval population. While, daily mean range of temperature exerted a negative highly significant influence on the population density of this pest. However, daily mean relative humidity has a variable effect on the larval population in both years of study.

Wilson (1991), reported that *Cirrosplius* sp. Hymenoptera: Eulophidae parasitised 10.5% of 475 CLM, larvae examined during October 1982. Up to 4 parasitoid larvae fed extremely on a single *P. citrella* larvae. In addition, Garrido and Busto (1994), mentioned that the following parasitoids emerged from CLM, larvae: *Pnigalio* sp., *Simpiesis sandanis* Walker, *Cirrospilus vittatus* Walker and *Cirrospilus pictus* Nees. Tawfik *et al*. (1996), recorded seven parasitoids belonging to Order Hymenoptera attacking *P. citrella*. Identified parasitoids from eulophidae, four species, i. e. *Cirrospilus quadristriatus* Evans*, C. pictus* Nees*, Ratzoburgiola incompleta* and *Sympiesis* sp. and one pteromalid species, i. e. *Peteromalus* sp. Other two species are *Pnigalio* sp. and *Baryscapus* sp.. Doumandji *et al*., (1999), found two Eulophidae were reared from *P. citrella*: *Cirrospilus pictus* and *Pnigalio*

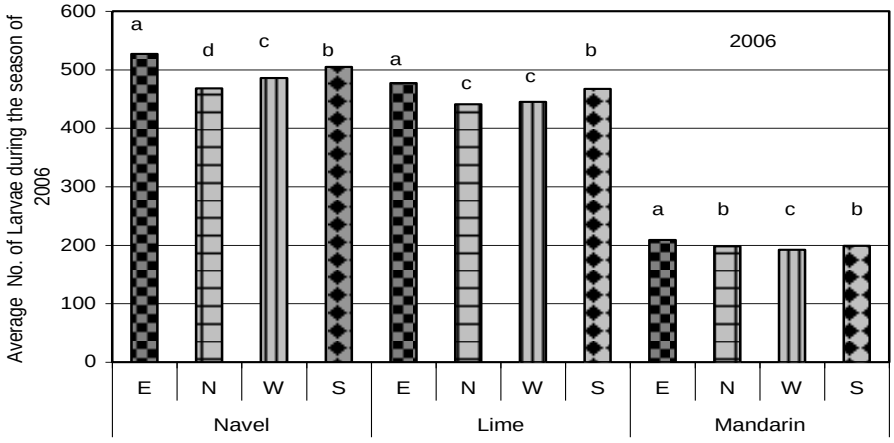
sp., *Cirrospilus pictus* was the dominant species, occurring in large numbers especially in summer. However, the impact of *Pnigalio* sp. remained low.

The agro-ecosystems components are changed with the changes in physical components (weather conditions), food suitability and the number of corresponding related natural enemies. These components seem to gave the corresponding changes in the population density of *P. citrella*.

3. The horizontal distribution:-

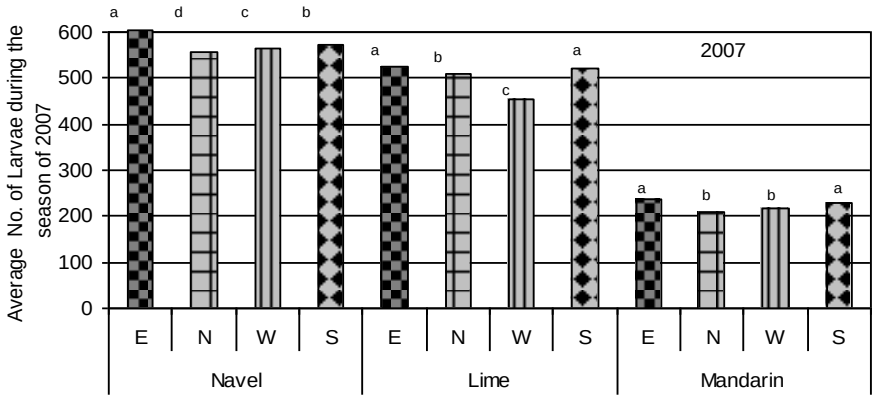
The data of the horizontal distribution of *P. citrella* larvae at the four cardinal directions (West, East, North and South) of the citrus trees during the seasons of 2006 and 2007 were summarized in Figures (2 and 3), for the two seasons of *P. citrella* at the four cardinal directions (W, E, N and S) of the citrus trees were statistically speaking, equal for both two seasons which indicate that the eastern and southern directions of the citrus trees has a significantly greater average number of *P.citrella* than the westren and northern directions of the trees. The overall results in 2006 and 2007, show that there is a significant effect for the trees direction on the abundance of *P. citrella* according to the data listed in Figures (2 and 3),

The above mentioned results are in agreement with those obtained by Mogahed (1999), who found, the tree directions of south and east were favoured for the multiplication of *P. citrella* more than other two directions north and west. Also Abd el-Rhman, (2005), found that there is significant effect of the direction of the trees on the abundance of *P. citrella* in eastern and southern sides. The significant differences were found between infestations in the geographical directions with *P. citrella* for the investigated species of citrus trees.



Means in each citrus species followed by different letters are significantly at P<0.05 (Duncan's Multiple range Test).

Fig. (2): Average no. of *P. citrella* larvae of cardinal directions of three citrus pecies at citrus orchard, Faculty of Agriculture Al-Azhar University during seasons of 2006.



Means in each citrus species followed by different letters are significantly at P<0.05 (Duncan's Multiple range Test).

Fig.(3): Average no. of *P. citrella* larvae of cardinal directions of three citrus species at citrus orchard, Faculty of Agriculture Al-Azhar University during seasons of 2007.

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ديناميكية التعداد والتوزيع لناخرة أوراق الموالح ***Phyllocnistis citrella*** على الأنواع المختلفة للموالح

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تم إجراء الدراسات البيئية على ناخرة أوراق أشجار الموالح في بستان الموالح -كلية الزراعة جامعة الأزهر، حيث أن الحشرة تصيب جميع أنواع أشجار الموالح. تمت الدراسة علي البرتقال أبو سرة، الليمون و اليوسفي وذلك خلال عامين ٢٠٠٦ ، ٢٠٠٧ م, ووجد أن البرتقال أبو سرة و الليمون أكثر الأنواع حساسية، بينما كان اليوسفي الأقل حساسية للأصابة. حيث بدأت الاصابة في السنة الأولي و الثانية في الأسبوع الأول من شهر مايو حتي الأسبوع الأول من شهر أكتوبر وكانت الاصابة في السنة الثانية أعلي من السنة الأولي. في السنة الأولي تم تسجيل من خمس إلي سبعة ذروات خلال هذه الفترة وكانت أعلي ذروة في ٣٠ يوليو حيث بلغ تعداد الحشرات علي البرتقال أبو سرة، الليمون و اليوسفي ١٩٢، ١٦٢ و٧٣ /٥٠ ورقة علي التوالي. بينما في السنة الثانية تم تسجيل من خمس إلي سبعة ذروات أيضا خلال فترة الاصابة وكانت أعلي ذروة في ٢٩ يوليو حيث بلغ تعداد الحشرات علي البرتقال أبو سرة، الليمون و اليوسفي ٢١٤، ١٩٢ و٨٨ /٥٠ ورقة علي التوالي. في سنة ٢٠٠٦ كان تأثير كل العوامل الغير حيوية (درجة الحرارة العظمي والصغري والمتوسطة) موجبة وعالية المعنوية، والرطوبة لها تأثير سالب وغيرمعنوي علي التعداد ، بينما كان تأثير العوامل الحيوية (الطفيليات) موجبة وغيرمعنوية. وفي السنة الثانية ٢٠٠٧ كان تأثير درجة الحرارة العظمي و الصغري و المتوسطة موجبة وعالية المعنوية, والرطوبة لها تأثير سالب وغيرمعنوي, بينما كان تأثير الطفيليات موجب وغيرمعنوي. والتأثيرالمتجمع لهذه العوامل كان ٦٦.٧٥ % في سنة ٢٠٠٦ بينما ٦٦.٦٥ % في سنة ٢٠٠٧. أما من ناحية تفضيل الحشرة للإتجاهاهات المختلفة فإتضح من النتائج أن تعداد الحشرة يفضل الاتجاه الشرقي و الجنوبي أكثر من الاتجاه الشمالي و الغربي.