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Fluctuations of aphid populations on grapefruit (*Citrus x paradisi* Macfad.)

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ABSTRACT

Very few studies were carried out to investigate the aphids attacking grapefruit. These pests cause considerable damages on citrus trees and other crops. This paper reports on the fluctuations of aphids on grapefruit in the region of Skikda (Algeria). From January 2012 to December 2013, monthly surveys were performed to measure the abundance of aphids recorded on 16 leaves of grapefruit. Through this study, five aphid species were identified, among them *Aphis spiraecola* Patch, 1914 was the most numerous. Besides, we noticed that the populations of aphids reached high levels many times within the year. However, the most important densities were recorded in spring and autumn.

Key words: *Aphis spiraecola*; *Aphis gossypii;* inter-annual variations of populations; intra-annual variations; population dynamics

IZVLEČEK

FLUKTUACIJE POPULACIJ LISTNIH UŠI NA GRENIVKI (*Citrus x paradisi* Macfad.)

Zelo malo raziskav je bilo narejeno na listnih ušeh, ki napadajo grenivko. Ti škodljivci povzročajo znantne poškodbe na citrusih in drugih kulturah. Pripevek poroča o nihanju pojavljanja listnih uši na grenivki v območju Skikda (Alžirija). Od januarja 2012 do decembra 2013 so bili opravljeni mesečni pregledi za ovrednotenje pogostosti listnih uši, na osnovi ocene pojavljanja na 16 listih grenivke. V raziskavi je bilo najdenih pet vrst listnih uši, med katerimi je bila vrsta *Aphis spiraecola* Patch, 1914 najštevilčnejša. Opaženo je bilo, da so bile populacije listnih uši številčne večkrat v letu, vendar so bile najpomembnejše gostote zabeležene spomladi in v jeseni.

Ključne besede: *Aphis spiraecola; Aphis gossypii;* medletna spremenljivost populacij; letna variabilnost; populacijska dinamika

1 INTRODUCTION

Citrus fruits represent one of the most important fruit productions worldwide, with 109 million tonnes produced annually in the world (Maserti et al., 2011). In the Mediterranean region, the citrus fruits play a very important role in the nutrition, human health, food processing industry and economic incomes (Biche, 2012). The genus *Citrus* includes several species of economic importance such as grapefruits (*Citrus x paradisi* Macfad.) (Hanke & Flachowsky, 2010), which constitutes the only major citrus varieties having a level of processed utilization comparable to oranges (Lacirignola & D'Onghia, 2009). It is the largest citrus fruit grown commercially in many countries (Skaria, 2004). The production of grapefruit was estimated at about 8,550100 tonnes in 2015, including 2300 tonnes in Algeria (FAO, 2017). Besides, grapefruit or grapefruit juice is often recommended as a healthy dietary constituent, particularly in some weight reducing diets (Xiao & Hu, 2014). Furthermore, other authors reported many healthy benefits of grapefruit (Xu et al., 2007; Yin et al., 2012). In addition, its zest is exploited in the production of pectin and essential oils (Kimball, 1999).

Several pests and diseases may attack grapefruit and reduce its yield. Among these plant enemies, aphids have a big importance. They comprise about 4000 described species, most of which are found only in temperate regions (Dixon, 1987). They cause direct (sap-feeding, deformation of their hosts) and indirect damage (transmission of plant diseases, deposition of honeydew on the leaves) (Cœur d'acier et al., 2010). For

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instance, *Citrus tristeza virus* (CTV) which is considered to be the most destructive virus of citrus crops (Rehman et al., 2016), is present in most of the countries in the Mediterranean region and is transmitted by different aphid species (Lacirignola & D'Onghia, 2009). Thus, knowledge of the biology of aphids is an important basis for successful management of the aphids themselves and of the diseases they transmit (Hales et al., 1997).

In Algeria, practically there is no specific studies on the aphids attacking grapefruit, although the importance of this aspect to obtain a good production qualitatively and quantitatively. Thus, our paper reports on the diversity and fluctuations of aphids on grapefruit in Skikda region (northeast Algeria), based on a two years investigation

2 MATERIAL AND METHODS

A citrus orchard at the Technical Institute of Fruit Arboriculture in Emjez Djich (6° 47' E and 36° 42' N, 200 m above the sea level), province of Skikda situated in northeast of Algeria, was used for this study. The trees were arranged in 5 m separated rows.

From January 2012 to December 2013, monthly surveys measured the abundance of aphids (adults and larvae) on grapefruit trees ('Shambar') grafted on Troyer citrange (*C. sinensis* L. × *Poncirus trifoliata* Raf.). Four young leaves from the four cardinal points per tree and four trees of grapefruit were selected randomly on each sampling date. Similarly, Yoldaş et al. (2011) and Mostefaoui et al. (2012) have sampled leaves to study citrus aphids.

Identification of collected aphids was carried out using identification keys especially those of Blackman & Eastop (2000) and Stoetzel (1994).

ANOVA analysis and Student-Newman-Keuls test were performed, by means of SPSS for Windows 10 software (SPSS Inc.), to compare the mean number of aphids between months and to classify homogeneous groups.

3 RESULTS AND DISCUSSION

Through 2012 and 2013, five aphid species were identified in total (Table 1). They are already reported on other citrus species in Algeria (Aroun, 1986; Benoufella-Kitous, 2005; Mohammedi-Boubekka, 2006; Belkahla et al., 2013; Benoufella-Kitous et al., 2014; Aroun, 2015; Labdaoui & Guenaoui, 2015; Lebbal & Laamari, 2016).

Citrus aphid species are widespread and four of them, *Aphis spiraecola* (Patch, 1914), *A. gossypii* (Glover, 1877), *Toxoptera aurantii* (Boyer de Fonscolombe, 1841) and *T. citricidus* (Kirkaldy, 1907), are especially abundant (Lapchin et al., 1994). Despite its presence in other Mediterranean countries, *T. citricida*, which is the vector the most implicated in the transmission of Tristeza disease (Lebdi Grissa, 2010), was not noted in the orchard of study. The complete elimination of Meyer lemon, the absence of the main vector *T. citricidus* and of natural transmission by other aphid species, have probably removed the risk of spreading the disease in Algeria (Larbi et al., 2009). Nevertheless, *A. spiraecola*, *A. gossypii*, *M. persicae*, and *T. aurantii* have some ability to transmit this virus (Bové, 1961; Ghosh et al., 2015). *A. gossypii* has been reported to cause major epidemics of CTV in the Mediterranean Basin (Yahiaoui, 2010)

Table 1: Number of individuals of each aphid species found on grapefruit in the examined orchard during 2012 and 2013

Aphids / Years	**2012**	**2013**
Aphis spiraecola (Patch, 1914)	388	1448
Aphis gossypii (Glover, 1877)	0	19
Toxoptera aurantii (Boyer de Fonscolombe, 1841)	3	0
Aphis nerii (Boyer de Fonscolombe, 1841)	0	5
Macrosiphum euphorbiae (Thomas, 1878)	0	1

The morphological characteristics of the identified aphids are described below

3.1 *A. spiraecola* (green citrus aphid or spiraea aphid)

This is a small yellow or greenish-yellow aphid with black siphunculi and cauda (Blackman & Eastop, 2007). Its body length ranges between 1.2 and 2.2 mm (Blackman & Eastop, 2006).

3.2 *A. gossypii* (cotton or melon aphid)

The coloration of adults, ranging in size from 0.8 to 1.5 mm, varies from light yellow or greenish to dark green. Their antenna are a little longer than half the (Célini, 2001). Cauda is lighter than siphunculi (Ilharco & Sousa-Silva, 2009).

3.3 *A. nerii* (oleander aphid)

Aptera are bright lemon yellow with dark antenna and legs, and black siphunculi and cauda (Blackman & Eastop, 2006). Antenna with terminal process more than three times length of base of VI (Stoetzel, 1994).

3.4 *T. aurantii* (black citrus aphid)

It is about 2.1 mm in length with striped legs (Fasulo & Halbert, 2015). Body of apterous form is dark-brown, while the apex of antennal segments III, IV and V, the apical half of base of VI and sometimes also the apex of terminal process are dark (Ilharco & Sousa-Silva, 2009).

3.5 *M. euphorbiae* (potato aphid)

It is a medium-sized to large, spindle shaped aphid, usually green but sometimes pink or magenta, the adult apterae often rather shiny in contrast to the immature stages, which have a light dusting of greyish-white wax (Blackman & Eastop, 2007). Siphunculi with a subapical zone of polygonal reticulation whereas the cauda is longer (Blackman & Eastop, 2000).

In our case, the most common species was *A. spiraecola* and with less degree *A. gossypii*. Tena & Garcia-Marí (2011) considered that these two species are the most harmful to citrus in the Mediterranean region. Its importance on citrus fruits has been mentioned, among others, in Algeria (Lebbal & Laamari, 2016), in Morocco (Elhaddad et al., 2016), in Syria (Abo Kaf, 2005) and in Turkey (Uygun & Satar, 2008). Whereas the weak infestation of *A. nerii*, *M. persicae* and *M. euphorbiae* on grapefruit in the studied orchard may be attributed to the competition from other species, particularly *A. spiraecola*.

On the other hand, ANOVA showed no significant difference of the infestation degree between months in 2012 (P = 0.156) and highly significant difference in 2013 (P = 0.000). The most important densities were recorded in spring and autumn (Figure 1), especially in April 2013 ($\bar{x}$ = 57.69 aphids / leaf), which coincide with the formation of new flushes and optimal temperatures.

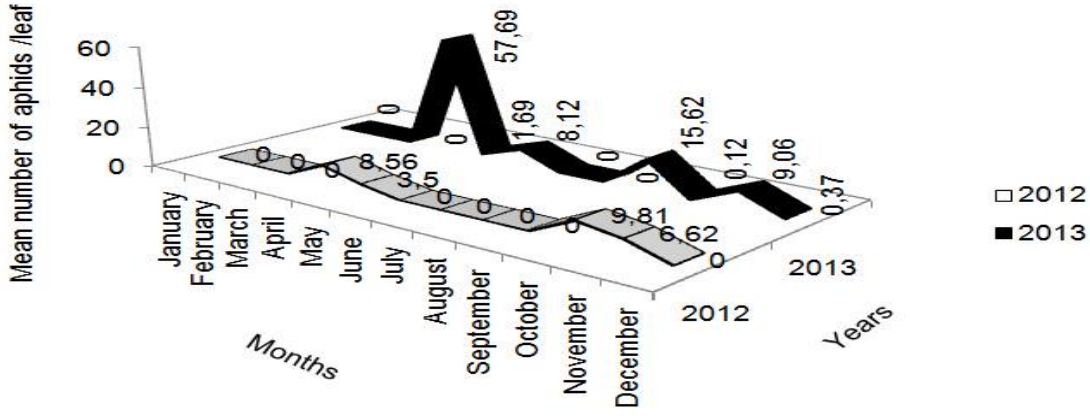

Figure 1: Mean number of aphids/leaf recorded on grapefruit in the examined orchard during 2012 and 2013

The correlation analysis for weather parameters and some citrus aphids indicated a significant negative correlation between minimum temperature and incidence of aphid species (Chavan & Singh, 2005). In addition, the presence and the abundance of citrus-dependent aphids depend on the population size of the different flushes (Saharaoui et al., 2015). Braham & Amor (2018) noticed a positive relationship between the number of new shoots per experimental tree and *A. spiraecola* infestation.

We observed an augmentation in the number of aphid species detected from two in 2012 to four species in 2013(Table 1). We also noticed big changes in the

distribution of aphids between years (Figure 1). For example, aphids did not infest grapefruit trees in five months during 2012, and in eight months during 2013. It seems that changes in climatic parameters between years influenced the infestation level. In the present study, the minimum temperature ranged from 9.48 to 27.37 °C in 2012; and between 11.24 and 25.22 °C in 2013 according to climatic data provided by the meteorological station of Skikda (longitude 6° 54' E; latitude 36° 52' N; altitude 1.30 m). Aphids are particularly sensitive to temperature changes due to certain specific biological features of this group (Hullé et al., 2010). The effect of temperature on the biology of many aphid species has been demonstrated (De Reggi, 1972; Kaakeh & Dutcher, 1993; Wang & Tsai, 2000; Morgan et al., 2001; Brabec et al., 2014; Ranila et al., 2015). Dixon & Hopkins (2010) revealed that for each species, there is a temperature range where the aphid can grow and reproduce. For example, Komazaki (1982) found that the intrinsic rate of natural growth is highest at 22 ° C for *A. gossypii* and 27 ° C for *A. spiraecola*. In addition, the generation time of the latter species was 5.8 days at 25 ° C and 12.1 days at 15 ° C, on orange (Satar & Uygun, 2008).

4 CONCLUSION

The present study focused on grapefruit, which represents an underutilized fruit tree although its benefits, allows the obtaining of new data about the aphids attacking this citrus tree in Algeria.

Five aphid species were identified, of which four species are considered as vectors of CTV causing the quarantine disease Tristeza. Furthermore, population fluctuations of these insects were very variable. Consequently, regular surveys in orchards, especially in the spring and autumn, are necessary to execute control measures to limit the attacks by these pests.

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