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RESEARCH ARTICLE

First biological data on the life history and population dynamics of *Octaspidiotus nerii* (Homoptera: Diaspididae), *Saissetia oleae* (Homoptera: Lecanidae) and *Pollinia pollini* (Homoptera: Asterolecanidae) on olive trees in the Blida Region (Algeria)

Guessab Asmaa[1,2], Biche Mohamed[1]

[1]Department of Zoology, Ecole Nationale Supérieure d'Agronomie, El-Harrach, Algeria
[2]Department of Agronomy, Faculty of Natural and Life Sciences, University of] [Mustapha Stambouli][, Mascara, Algeria
Corresponding author E-mail: guessab71@gmail.com; a.guessab@st.ensa.dz

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The work consists of a study on the level of infestation of the 3 species of olive-infused mealybugs at the two stations (Soumaa and Guerrouaou) in the Blida région, with particular attention to the évolution of *Pollinia pollini (Asterolecanidae), Octaspidiotus nerii (Diaspididae) and Saissetia oleae* (*Lecanidae).* Unlike the Soumaa station, there is a large infestation in the Guerrouaou station by the three (most abundant) species with a high rate. The life cycle monitoring and the bio-ecology of these three pests were carried out through periodic population counts on the leaves and twigs of the tree from 08 August 2016 to 29 May 2017 in the wilaya of Blida. It appears that the study of the biology of *P. pollini* evolves in 2 annual generations (the first is the spring generation; the second is through the summer. The larval stage remains the most abandoned compared to other developmental stages. The South orientation seems the most affectionate by *P. pollini*. We can conclude that *O. nerii* has two generations « spring and automne » depending on climatic factors. The East and West exposure represent the places most sought after by this scale where we found a relative abundance between larvae and adult females. *S. oleae* develops only one generation per year (automnal génération). Females are the most abundant in Soumaa station and larvae in Guerrouaou station. The eastern orientation and the automne season are the most favourable for the development of the mealybug.

Keywords: Olive tree; *P. pollini; A. nerii; S. oleae;* Infestation; Generations; Orientation; Season; Life cycle

Introduction

Algeria is one of the main Mediterranean countries with a more favourable climate for olive growing. It is positioned after Spain, Italy, Greece, Turkey, Syria, Tunisia, Morocco and Egypt, which are the largest producers of olives and olive oil. The olive growing area of our country is constantly increasing. To catch up and why not win a more honourable place in the world rankings (Sidhoum,2011). In 2016, Algeria only exploited 18% of its olive trees. 82% of their by-products evaporate in nature. Olive production is limited by several diseases and pests, leading to crop losses (El hadrami and Nezha, 2011). The study of the entomofauna of the olive tree offers a great ecological interest. It aims to characterize prevention strategies against harmful species using species useful in the same ecosystem. Scale insects 0are recognized as primary or secondary pests on many crops. These Homoptera, often pests them crops and have a +stinging sucking feeding mode and feed on plant sap. Historically, the classification of scales is based on female morphology. Currently in Algeria, the mealybugs most closely associated with the olive tree are considered invasive alien species distributed mainly in three families: Coccidae, Diaspididae and Asterolecanidae. The Asterolecanid family includes scales that usually secrete a very difficult follicle to separate from the insect's body. This group of insects is represented by the genus Pollinia (silvestri, 1920). *Pollinia pollini* (Costa, 1857) is a widespread species in all olive-growing countries of the Mediterranean basin (dellabefa, 1948). It is specific to the olive tree and poses economically important problems to the olive cultivation in Tunisia since 1952 (damiano, 1963, kamoun, 1971), in Algeria (Arambourg, 1975 and loussert and brousse, 1978, bourahla and biche, 1992, mahmouche, 1992 and Ouatassou, 1993) and in Palestine (arambourg, 1975). In Tunisia, it is considered the most important pest of the maritime regions after the olive fly, Batrocera oleae (damiano, 1963). It was introduced in California in 1980 and in Argentina in 1984 with olive plants. Stages of development according to arambourg (1986);

Egg: White, almost spherical oval in shape and becomes more elliptic when the larva is formed.

Larvae: Yellowish to orange in colour, 1-1.5 mm long. The larva is flattened, elliptical with the last abdominal segment bilobed. Each lobe is lined with a long silk, antennae to 6 items. Like all mealybugs, *P. pollini* has two larval and one adult stages in females and four larval and one adult stages in males.

Adult female: Ovoid, globose, apode, it is enclosed in a yellowish gray follicle, spherical, hard, easily blending with the bark of the tree.

Male adult: With a hazelnut colour, long abdomen, provided with a pair of wings, 9-piece antennae.

The family of Diaspididae; Called shield scales, they are considered the most advanced. Octaspidiotus nerii (Bouché, 1833) is a cosmopolitan species and very polyphagous on various hosts of economic importance. According to TELLO (2010), eggs are oval-shaped and yellowish in colour. Outbreaks give two larval stages (L1, L2). Only the first stage L1larva is mobile. The second stage L2 larva is fixed with a difference between female and male L2. The L2female is circular while the male L2 is narrower than the female. In the male, L2 is followed by a pre-nymph; a nymph and finally the winged adult (BALACHOWSKY, 1953; BICHE, 2012). The male's shield is oval in pure white matte colour with eccentric larval exuviae. Females have a circular or subcircular shield with a diameter of 1.5 to 2 mm. This shield is white to light grey and flattened slightly convex, while larval exuviae are subcentral. The body is 0.9 mm long and yellowish in colour. It is pyriform and remains membranous except pygidium with three pairs of well-developed lobes (Tello 2010). The family of Lecanides (Coccidés); Called carapace mealybugs, they produce honeydew and their protective shell is not an external structure erected by the insect. Saissetia oleae (Olivier, 1791); The black olive scale or the H scale is also a very polyphagous species. The adult female is 2-5 mm long and 1-4 mm wide, varying in colour from light brown to young to dark brown or blackish. Despite the reported presence of males, reproduction is parthenogenetic. Despite the reported presence of males, reproduction is parthenogenetic. Female fecundity ranges from 150 to 2500 eggs with an average of 1000 eggs (C.O.I. 2007). The eggs are oval with pointed tips, 0.26-0.32 mm long and 0.13-0.22 mm wide. They have a whitish colour that changes to orange pink as it evolves (C.O.I. 2007). There are three stages of larval development (C.O.I 2007). The adult male is usually, very rare to observed. It is a winged, honey-yellow, about 1 mm long (QUAYLE 1911).

Materials and Methods

Presentation of the study area

The Blida région is located in the central part of the Mitidja (MUTIN, 1977). La Mitidja is located at a latitude of 36 to 48 and an average altitude of 30 to 50 metres (loucif and bonafonte, 1977). For this work, we have chosen two olive groves in order to highlight the influence of the maintenance of an olive grove on the ecology of mealybugs. For this we have chosen an olive grove located at the University of Blida "Soumaa" (36° 29′ -36°44′N; 2°25′ to 3°17′E) well maintained and another located in Guerrouaou (36°31'N, 2°53'E) in an abandoned state.

Expérimental protocol

In the Field: For this study, we have delimited 1 ha in each station. The two study olive groves are divided into 9 sampling plots composed of 16 trees each. Samples are taken every 10 days from two trees in each random plot. The method consists of taking 2 trees on which are taken 1 branch of 20 cm long and 10 leaves; this in each cardinal direction (North, South, East and West) of the tree. The samples collected are placed differently and immediately in Kraft paper bags with all contact information (date, direction, etc.).

In the laboratory: The selected twigs and leaves are carefully examined under a binocular lens. The different life stages of the mealybugs are quantified on both sides of the leaf as well as on the twig of each cardinal direction and recorded on cards bearing the date of exit, the number of the tree and the direction of sampling. For each stage, we quantify the total number of live, dead individuals in order to assess the state of infestations of the insect over time.

Results and Discussion

During our work, we recorded the order of Homoptera containing 5 species divided between 3 families, almost all inferior to the olive tree. These are the scales; Saissetia oleae (Lecanidae), *Pollinia pollini* (Asterolecaniidae), Octaspidiotus nerii (Diaspididae), Lepidosaphes flava (Diaspididae), Parlatoria oleae (Diaspididae). The results show that Station 2 (Guerrouaou) has a higher rate of scale infestation compared to Station 1 (Fac de Blida). Hanifi (2011), Chenoua (2012), and Djoumadi (2012), Boukharcha (2013), working in the Soumaa (Blida) station, MENZER et al., (2016), in the Guerrouaou (Blida) station, confirm the présence of all olive-infused mealybugs. On the other hand, In the Mila région (Algeria), HARRAT (1988) recorded Diaspididae scales which are not included in our results such as Getulaspisbupleuri, Lichtensiaviburni, Diaspidiotuslenticularis (Diaspididae).

Pollinia pollini:

Global population dynamics: An overall review of population fluctuations of the olive scale shows clearly that *P. pollini* develops two générations per year. The spring period seems to be the most favourable for the development of the scale. However, we can notice 2 periods of intense activity of the mealybug in the station of Guerrouaou: The first is noted during the beginning of the month of August (858 individuals), the second during the month of April (926 individuals). while there are 2 peaks in station1; the first peak in August (240 individuals) and 345 individuals in April (Figure 1). The majority of authors agree to count 2 générations according to the influence of climatic conditions and the state of the olive grove whether in Algeria, (Arambourg, 1975 and Loussert and Brousse, 1978, Bourahla and Biche, 1990, Mahmouche, 1992, Ould aissa, 1992, Ouatassou, 1993 and Menzer et al., 2016) or in Tunisia (Damiano, 1963 and Kamoun, 1971). Data are reported by Ahmed (2012) in Egypt, Palestine (Arambourg, 1975), Alexandrakis (1980) in Greece, Ertem and Pehlivan (1995) in Izmir (Turkey). Thus, in Spain, the second generation is considered accidental. In contrast, in Italy, in the area south of Sicily, the mealybug is monovoltine (Liotta and Sammartano, 1981).

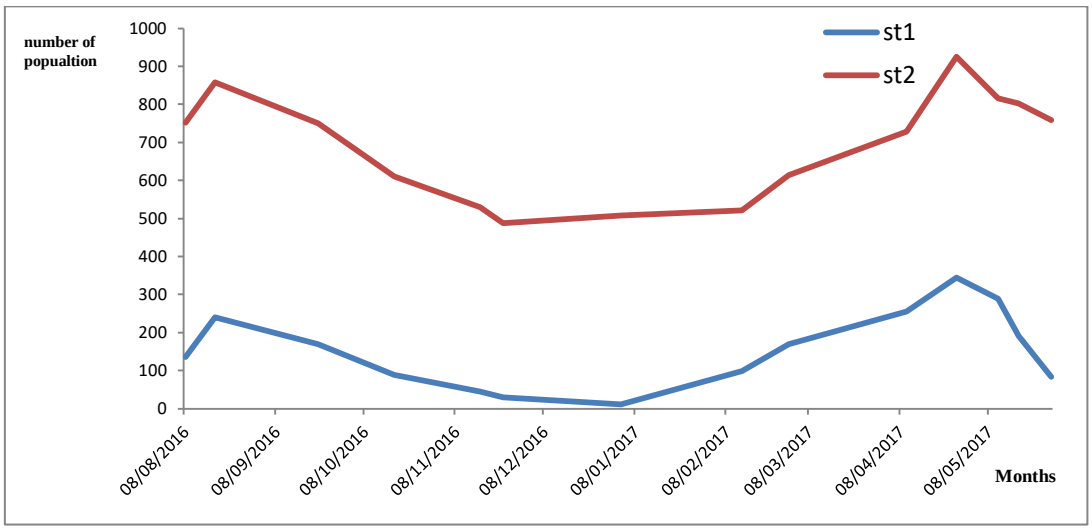

Figure 1. The Overall fluctuation of *P. pollini* populations on the olive tree in the Blida région.

Distribution according to the stages of development and the season: Based on the results shown in Figures 2 and 3, it is noted that the larval stages are most abundant in the scale populations at both stations. In fact, these larvae display 62.63% in station 1 and 50.94% in station 2. The spring season is the most favourable season for the development of the mealybug.

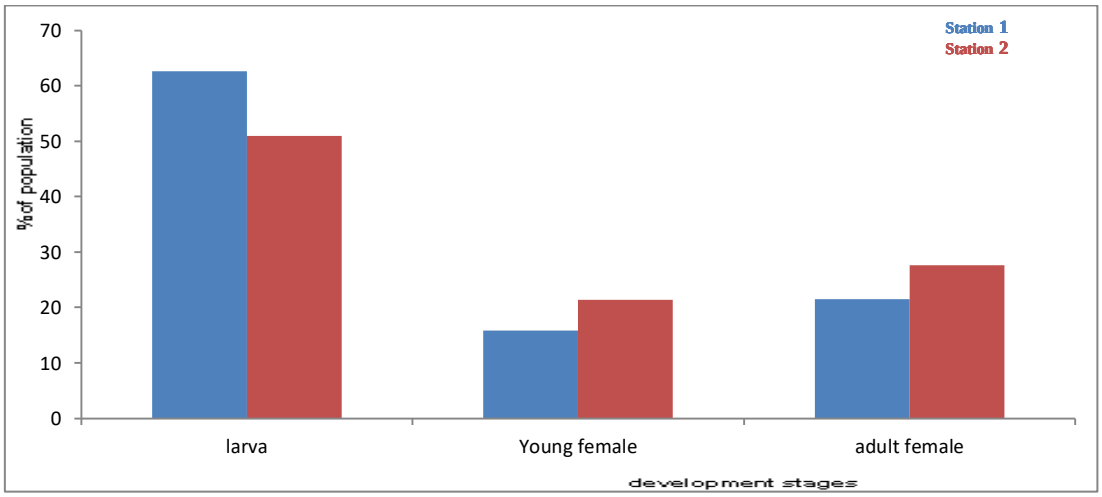

Figure 2. Abundance of developmental stages of *P. pollini* on the olive tree in the Blida région.

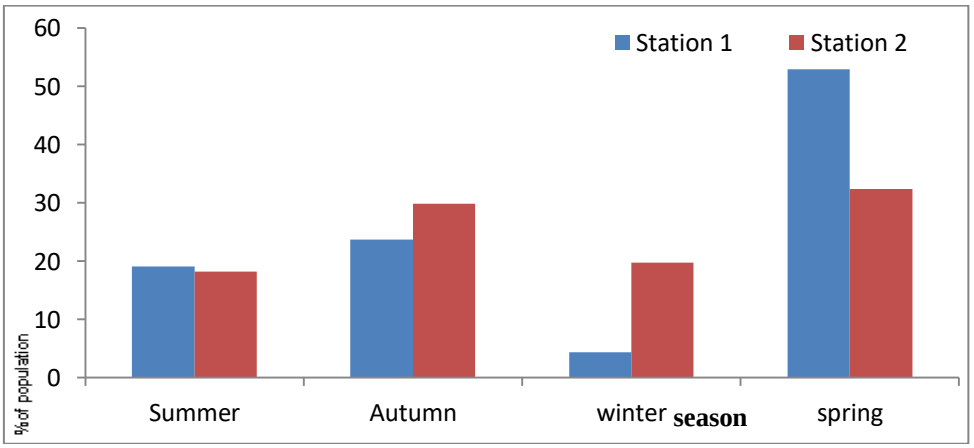

Figure 3. Seasonal abundance of *P. pollini* on the olive tree in the Blida région.

Cardinal distribution: The results obtained and illustrated in Figure 4 for the total numbers of the different stages of development show that the South orientation (37.81% in station 1 and 29.93% in station 2) and the East orientation (28.99% in station 1 and 27.21% in station 2) represents the most sought-after places. Indeed, *P. pollini* has a more or less marked affinity for the areas most exposed to the sun. The other orientations are less populated by the mealybug.

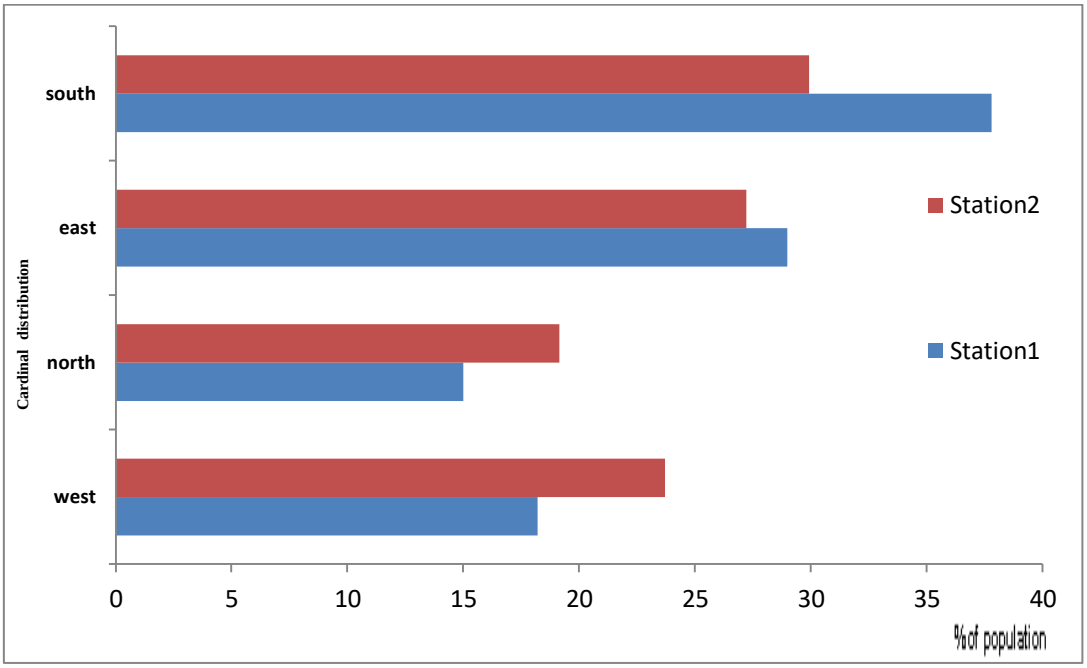

Figure 4. The cardinal distribution of the *P. pollini* on the olive tree in Blida region.

2. *Octaspidiotus nerii*:

Overall population dynamics: The results of the population dynamics are obtained during the period from 8 August 2016 to 29 May 2017 of field trips clearly show that *O. nerii* develops two générations per year (autumn and spring). We can observe 2 periods of intense activity of the cochineal, the first (627 individuals in station 1 and 331 in station 2) and the second (761 individuals in station 1 and 889 in station 2). The Mann-Whitney test gives a non-significant two-sided difference between the two sampling stations, since the populations have the same variations from one station to another (Figure 5).

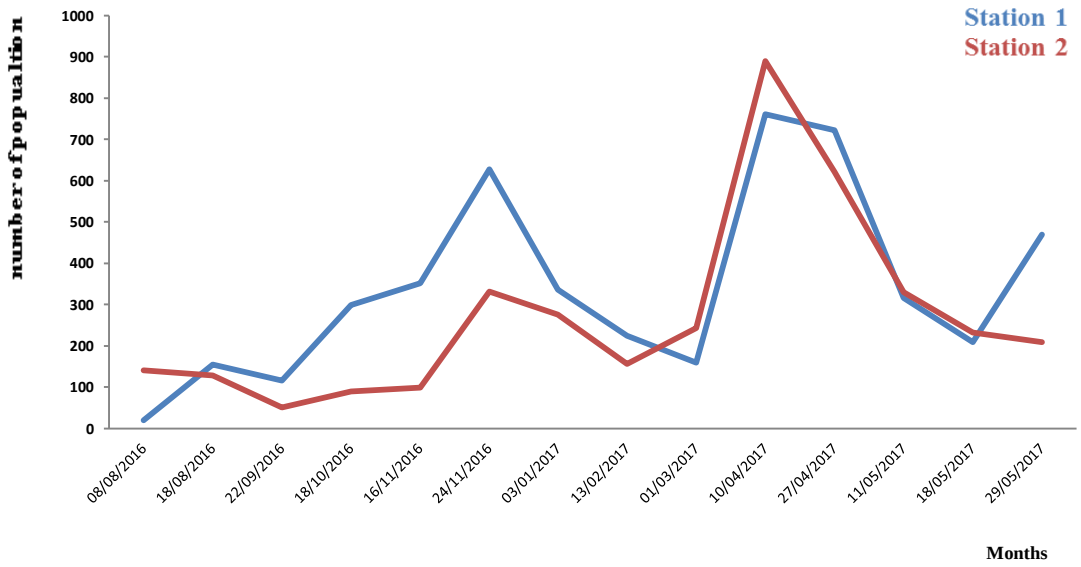

Figure 5. The Overall Fluctuation of *O. nerii* populations on the olive tree at the two stations in the Blida région.

Distribution according to the stages of development and the season: According to the results illustrated in Figures 6 and 7, it can be seen that the larval stages are the most abundant in station 2. Adult females are the most infested in station 1. In fact, these larvae show 61.43% in station 2 and adult females show 57.51% in station 1. Young females, nymphs and males do not exceed 15% at both stations. The spring season is the most favorable season for the development of the cochineal. Octaspidiotus nerii seems to be dependent on the climatic conditions offered by the seasons. For the Soumaa or Guerrouaou station, the recorded rate coincides with the spring sap surge (55.35% for station 1 and 66.52% for station 2).

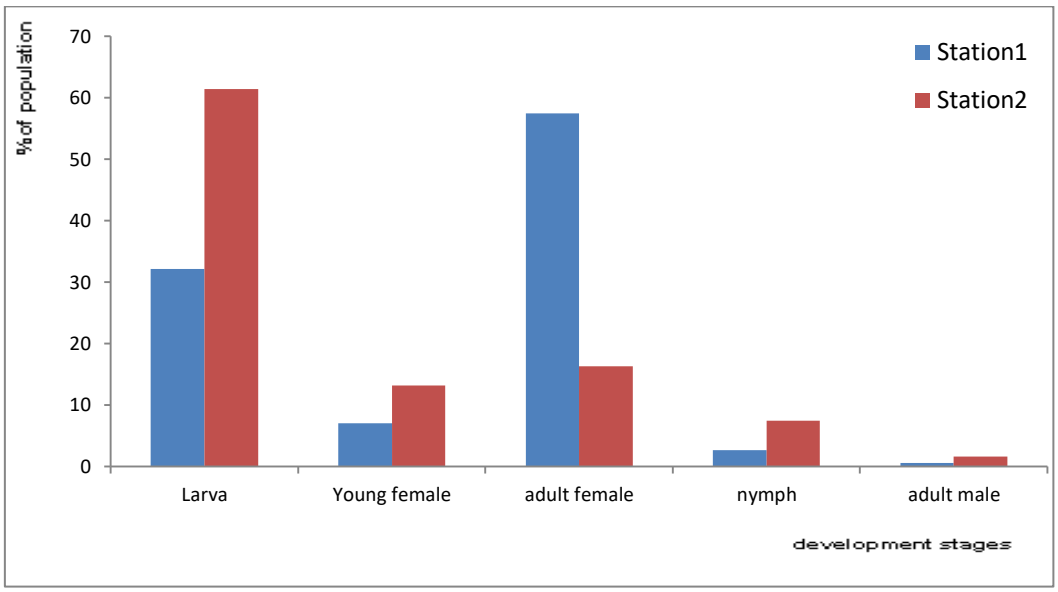

Figure 6. Abundance of developmental stages of *O. nerii* on the olive tree in the Blida région.

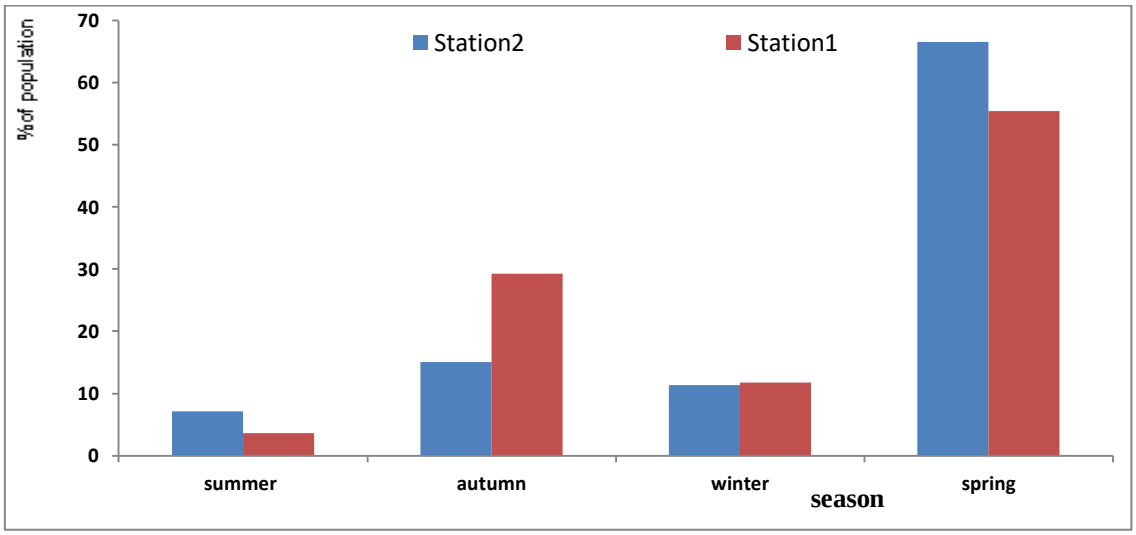

Figure 7. Seasonal abundance of *O. nerii* on the olive tree in the Blida région.

Cardinal distribution: The climate is a limiting factor for pests in général and in particular mealybugs. The results of Figure 8 shows that the East orientation is most favored by this scale with a percentage of 36.92% in station1 and 31.35% in station 2. This place seems to be a preferential place for this cochineal. The spatial distribution of this species on the tree is closely related to the microclimate created within the tree. *O. nerii* has a more or less marked affinity for the areas most exposed to the sun.

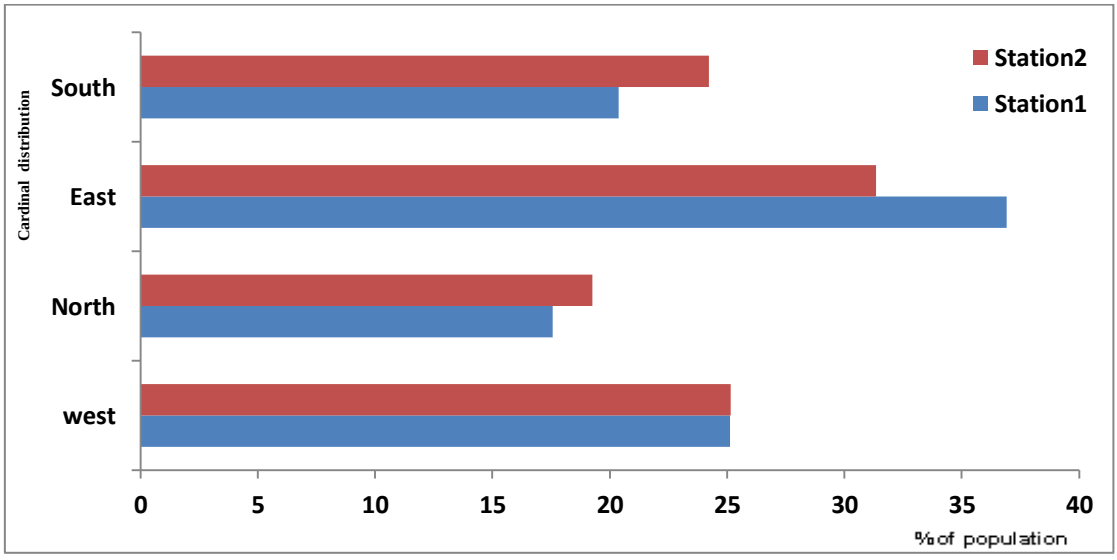

Figure 8. The cardinal distribution of the *O. nerii* on the olive tree in Blida region.

Saissetia oleae:

Global population Dynamics: The results mentioned in Figure 9 shows that the cochineal develops only one génération the Blida région. The most important peak is recorded in autumn. With normal flow of the sap flow (PS2), at the beginning of October, a maximum percentage of 348 individuals of *S. oleae* was observed in station 1 and during the month of November (112 individuals) for Guerouaou station. Our results agree with those of DJOUMADI (2012) in the Blida région at the Soumaa station, where he thought that the black olive scale mealybug presents only one generation per year (autumn generation). In Lebanon, in the région of Goddrass-Kesrouan, MECHELANY and DACCACHE (1998) note that Saissetia oleae has one génération per year.
On the other hand, in Greece, CANARD and LAUDEHO (1977) stress that this cochineal shows two generations per year.

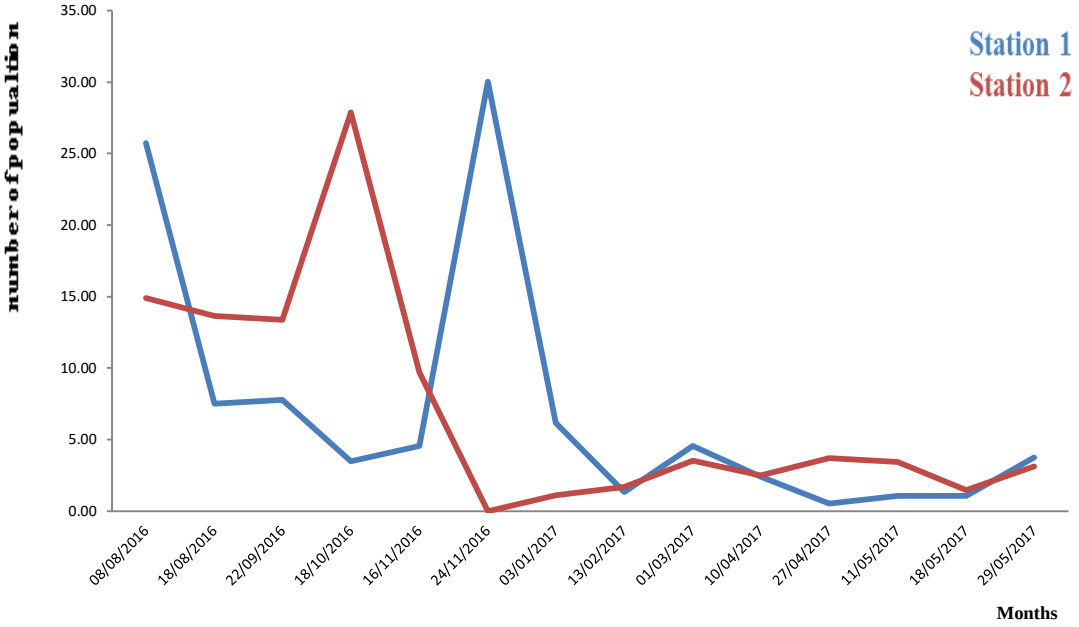

Figure 9. The Overall Fluctuation of *S. oleae* populations on the olive tree in the Blida région.

Distribution according to the stages of development and the season: From the results shown in Figures 10 and 11, we see that the larval stages are most abundant in station 2 with a rate of 85.52%. Adult females are most abundant in station 1 with a rate of 62.18%. The Autumn season is the most favorable season for the development of the mealybug. In Essaouira in Morocco, L1s and females (lower numbers) are present from April to July, against L2s which are not counted from March to May. While L3s only appear in September through May (Ouguas and Chemseddine, 2011).

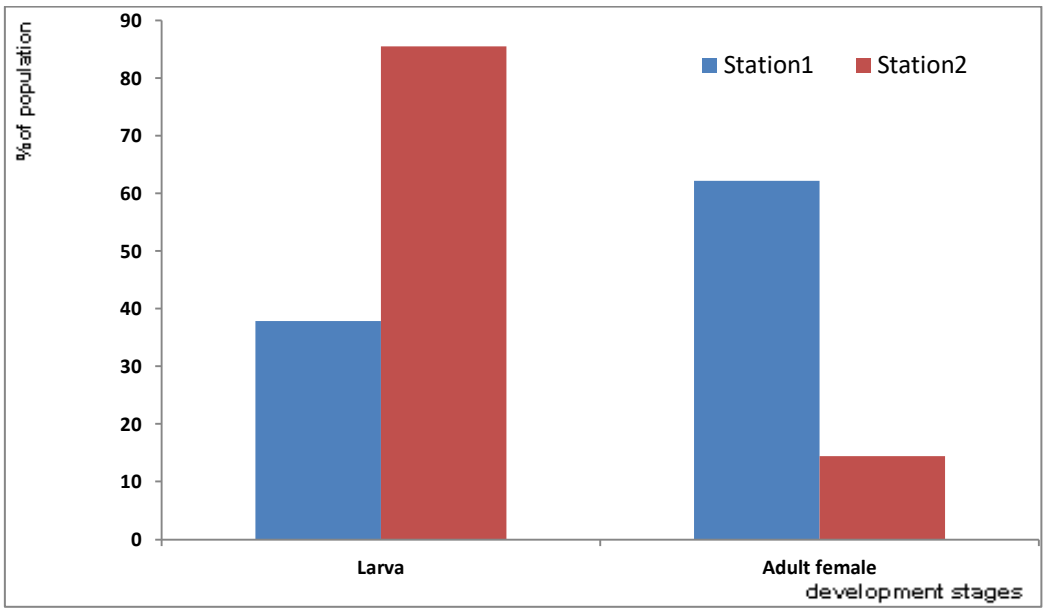

Figure 10. Abundance of developmental stages of *S. oleae* on the olive tree in the Blida région.

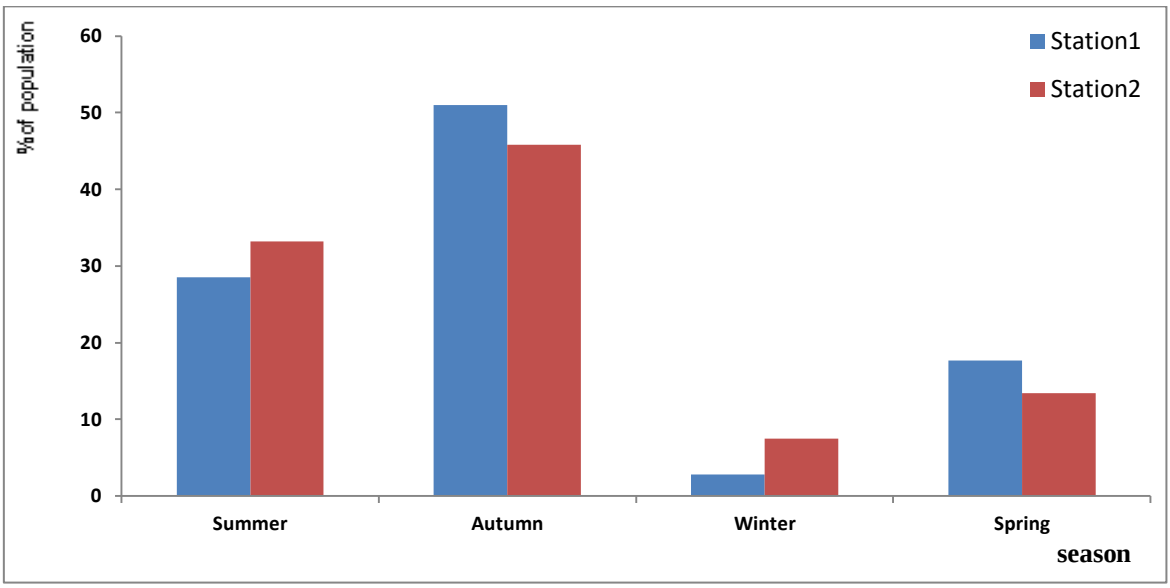

Figure 11. Seasonal abundance of *S. oleae* on the olive tree in the Blida région.

Cardinal distribution: The results reported in Figure 12 show that the East orientation (32.61% in station 1 and 40.21% in station 2). Indeed, *S. oleae* is a thermophilic species. In Morocco, EL HomritI and Laraichi (1979) indicate that the direct action of the environment on populations of *Saissetia oleae* results in high mortality under the effect of high summer temperatures. On the other hand, Djoumadi (2012) reports that in the région of Blida has temperatures which vary from 25°C to 27°C which favor the abundance of individuals of the black olive scale.

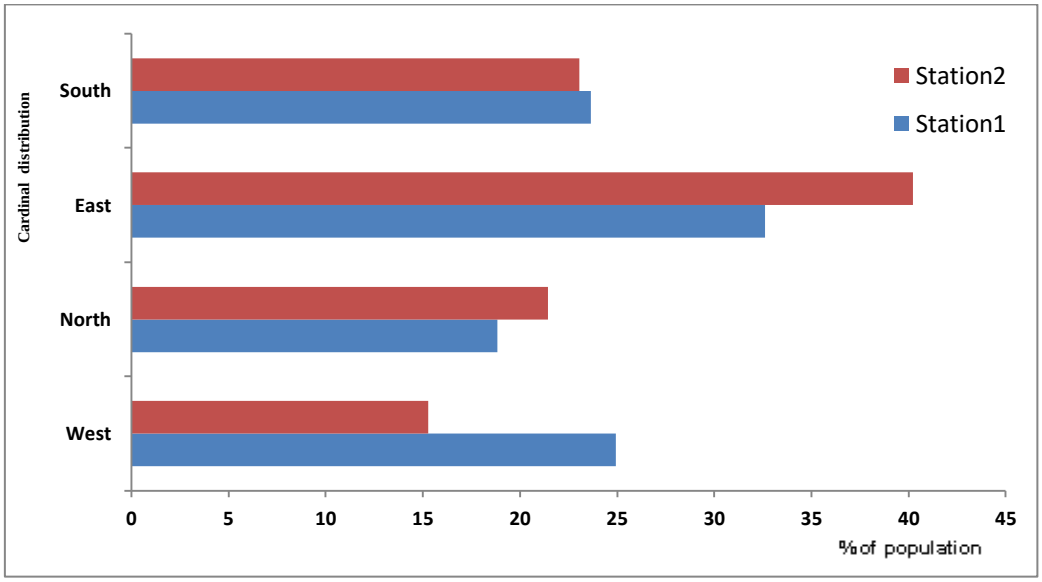

Figure 12. The cardinal distribution of the *S. oleae* on the olive tree in Blida region.

Conclusion

Our work was focused on the level of infestation within the two experimental stations where we found 5 species of Homoptera subservient to the olive tree in the région of Blida by treating the population dynamics of the 3 main cochineals (*Pollinia pollini*, Octaspidiotus nerii, Saissetia oleae), through observation of twigs and leaves.

During the study period, the influence of concomitant factors (climatic conditions, cultivation practices, phenomena related to the biology of the pest, plot environment, etc.) on the level of infestation of coccids between two olive groves (Soumaa and Guerrouaou). Despite the lack of data on these 3 scale insects. We can deduce that *P. pollini* is a heliophilic species, specific to the olive tree and which overwinters at the young female and adult female stage. *P. pollini* develops in 2 annual generations: a spring generation and a summer generation. The larval stage is the most abandoned compared to the other stage of development. The south orientation seems to be the most popular with *P. pollini*. The spring period is favored by the rise in temperature and the vegetative awakening, the laying begins during this period. The population of Octaspidiotus nerii occurs in a single generation, and if conditions are favorable it can develop a second generation. It appears that the study of the biology of *O. nerii* allowed us to conclude that she has two generations; spring and autumn depending on climatic factors. The East and West exposure represent the rights most sought after by this mealybug, where relative abundance has been found between larvae and adult females. Seasonal climatic conditions and the host plant are a factor regulating the evolution of this diaspin: spring is the most favorable season for the outbreak of *O. nerii*.

The results mentioned allowed us to estimate that *S. oleae* develops only one generation per year (autumn generation). The H cochineal has a more or less marked affinity for the east orientation for the different stages of development, while the females are

most abundant in the Soumaa station and the larvae at the Guerrouaou station. The east orientation and the spring season are the most favorable for the development of the cochineal.

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