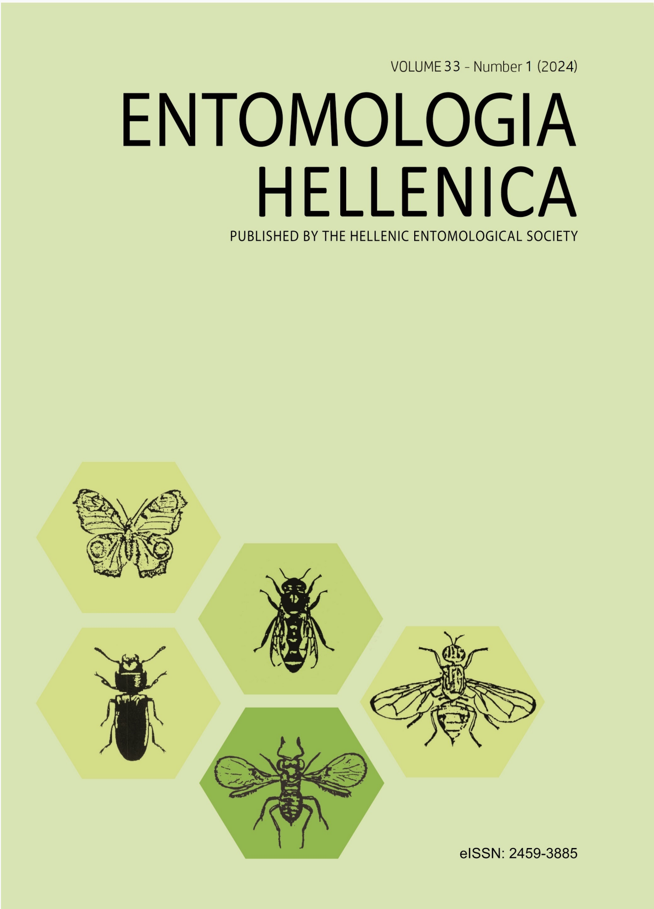
ENTOMOLOGIA HELLENICA

Vol 33, No 1 (2024)

Entomologia hellenica 33(1)



Influence of the region and the sap flow of orange trees on the population dynamics of Aonidiella aurantii (Hemiptera: Diaspididae) in Mitidja (Algeria)

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ENTOMOLOGIA HELLENICA **33** (2024): 1–14

Received 10 April 2024 Accepted 09 June 2024 Available online 11 June 2024

Influence of the region and the sap flow of orange trees on the population dynamics of *Aonidiella aurantii* (Hemiptera: Diaspididae) in Mitidja (Algeria)

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ABSTRACT

The objective of this work is to study the influence of the region and the sap thrust on some bioecological aspects of the red scale *Aonidiella aurantii* (Maskell) (Hemiptera: Coccomorpha: Diaspididae). The monitoring of the life cycle of *A. aurantii* has been conducted by periodic counting of populations on different parts of the tree such as branches and leaves during two consecutive years (2017 and 2018) in the region of Rouiba [36°44′00″N; 3°17′00″E] and Oued El Alleug [36°44′00″N; 3°17′00″E]. The study of population dynamics shows that the armored scale develops three annual generations on the orange tree in the regions of Rouiba and Oued Alleug, which also coincide with the three flushes of sap: spring, summer and autumn. The spring period also remains the most favorable for its development. In addition, it has a very marked affinity for the center orientation and the branches of the tree, which offer it the optimal conditions for its development. As for the previous species, the shift observed in the temporal distribution depends essentially on the region (distance from the sea) but also on the triggering of sap surges. In fact, it was determined that the three periods of activity in Oued Alleug began a little later compared to those in Rouïba. In autumn and winter, the crawlers of the red scale insect are more abundant in the center of the tree while in spring and summer they shelter in the east of the tree where the climatic conditions are more favorable. The average values of fecundity

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varied from 1 to 20 crawlers/female in Rouïba, while in Oued Alleug, from 0 to 19 crawlers/female. The analysis of variance reveals that the factor year, month and region induce a very highly significant difference ($p<0.0001$) in the two years in the region of Rouïba and Oued Alleug with a probability of ($p<0.0001$). The distribution of neonate larvae was a good indicator for understanding the red scale insect behavior. The findings of this study have huge implications for *A. aurantii* control of red scale.

KEY WORDS: Sap thrust, orange tree, Rouiba, Oued Alleug.

Introduction

Citrus fruits are economically important in monetary value, since this sector has an agricultural upstream and an industrial downstream, because in addition to the fresh sold products, a certain quantity is destined for processing. They represent the most important fruit group in international trade (Koutti and Bounaceur, 2013).

The orange culture occupies a very important part in the production of citrus fruits, and it represents a strategic segment for our country. The production of oranges evolves from one year to another. This is reflected by the input of young plantations planted in the recent years under the national agricultural development plan (MADR, 2015). Unfortunately, this production is confronted with several difficulties, the most important of which are those related to diseases and pests. The diseases, such as psorosis (Citrus psorosis virus (CPsV)), tristeza (Citrus tristeza virus (CTV)) and *Phytophthora* gum disease are predominant in old plantations. Pests, such as scale insects, aphids, whiteflies, mites, leafminers etc cause enormous damage and affect the quality of citrus orchards (Jacquemond et al., 2013). Hemipterans, can cause significant yield losses or at the very least, diminish the quality of crops and cause marketing problem (Quilici and al., 2003; Biche et al., 2012). Citrus pests are numerous, amongst them is included the red scale *A. aurantii* (Maskell) (Hemiptera: Coccomorpha: Diaspididae). This armored scale insect is considered as one of the key pests of citrus worldwide (Quilici, 1993). If not effectively controlled, it can cause complete desiccation of infected trees within two to three years (Walker et al., 1999). In Algeria, studies conducted on the bioecology of the red scale are few (Biche et al., 2012; Belguendouz et al., 2013; Biche et al., 2016).

In recent years, a recrudescence of red scale has presented severe infections on most of the citrus plants including lemon trees, bitter orange trees, clementine trees and orange trees, where the degree of attack is the same on the fruits as on the branches and the leaves. The aim of this work was to study red scale, which has both a qualitative and quantitative impact on fruits, its reproductive biology, dynamics, how they distribute in the plant and how they are affected by seasonal distribution of crawler (mobile larvae) according to cardinal orientations and the composition of natural enemies on orange in Rouiba and Oued El Alleug for two years to be able to improve control and interventions.

Materials and Methods

Study site. This work was carried out in two study sites in the east and west of the Mitidja. The first site is a private farm (agricultural exploitation) located in the commune of Rouiba, Algers [36°432N 3°162E], 7 km from the Mediterranean Sea and at an altitude of 17 m. The second site is also a farm located in the commune of Oued El Alleug, Blida [36°332N 2°472E] and it is at an altitude of 54 m. Both sites contain several varieties of citrus. This experiment was conducted in an orange orchard (Figure 1).

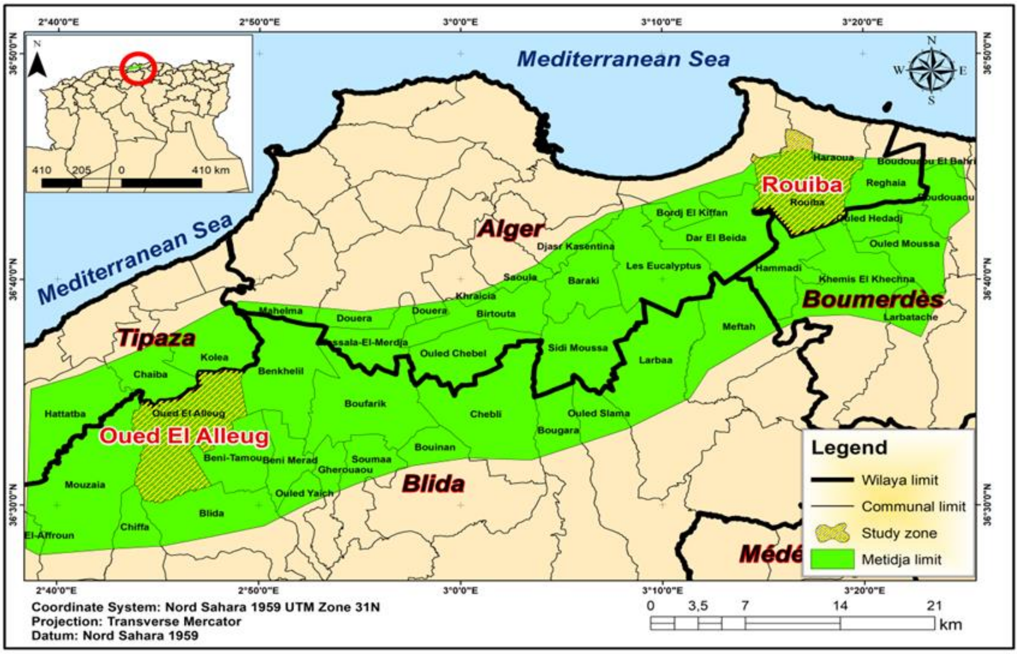

FIG. 1.**:** Localization of the studied field in Mitidja (Algeria).

Sampling and counting. The study was conducted between the beginning of December 2015 and December 2017. Vasseur's and Schvester (1957) method was used to accomplish this study. The sampling was done every 10 days, 3 times per month (36 outing per year in general). The survey orchards were divided into 9 plots, each plot containing 24 trees (216 trees in total). For each survey, 2 trees from each sample plot were randomly sampled; a total of 18 trees were sampled. Two branches of 20 cm of length and two leaves at man height for each cardinal direction and on the center of the tree were taken. The samples were placed in Kraft paper bags on which all the sampling information (date, direction and region) were mentioned. Along with the sampling, we supplement our observations by recording the dates of the sap bursts and the phenological stage of the host plant in the two sites (flowering, fruit set, growth and maturation).

In the laboratory, the counting method comprised of recognizing and counting of the different stages of development of the red scale insect on both sides of the leaves as well as on the branch for each cardinal direction, under the binocular magnifying glass. On the sampling cards the number of living individuals of each stage.

Data exploitation and statistical analysis. The data were submitted to the various statistical analyses to study the dynamics of the total population of *A. aurantii* on orange tree in the regions of Rouiba and Oued Alleug.

Fecundity (F) of *A. aurantii* and the seasonal distribution (D) of crawler according to orientations were calculated using the following expressions:

F = Number of crawlers (mobile larvae) / Number of females

D = Number of crawler of each orientation of the red scale*100 / Total number of crawlers.

One-way analysis of variance (ANOVA) was conducted to compare the effect of cardinal direction on the distribution of *A. aurantii* at different seasons. When there were statistically significant differences at $p<0.05$, Duncan's multiple range test (DMRT) was used to separate the means. SPSS (version 23) was used for the analysis.

Results

Population dynamics

The results of the dynamics of the global population of orange tree in Rouïba and Oued Alleug were obtained during the period from January 4, 2016, to December 21, 2017, that is, a period of 2 years. The results reported in Figure 2 allows us to distinguish three periods of intense activity: spring, summer and fall in the two study sites. They practically coincide with the three sap flushes. The first one has larger numbers and lasts about four to more five months. The second one, with less numbers and lasts about three to five months. The third one, on the other hand, lasts only two months with lower numbers. It is noted that the red scale insect presents a different behavior according to the region.

Indeed, we noticed a shift in the development of the populations of *A. aurantii*. The three periods of activity in Oued Alleug started a little later compared to those of Rouïba. We noticed a delay of 18 days in 2016 and 17 days in 2017 for the first generation. For the second generation, there was also a delay of 18 days in 2016 and 24 days in 2017. Finally, for the third generation, we noted a delay of 43 days in 2016 and 18 days in 2017.

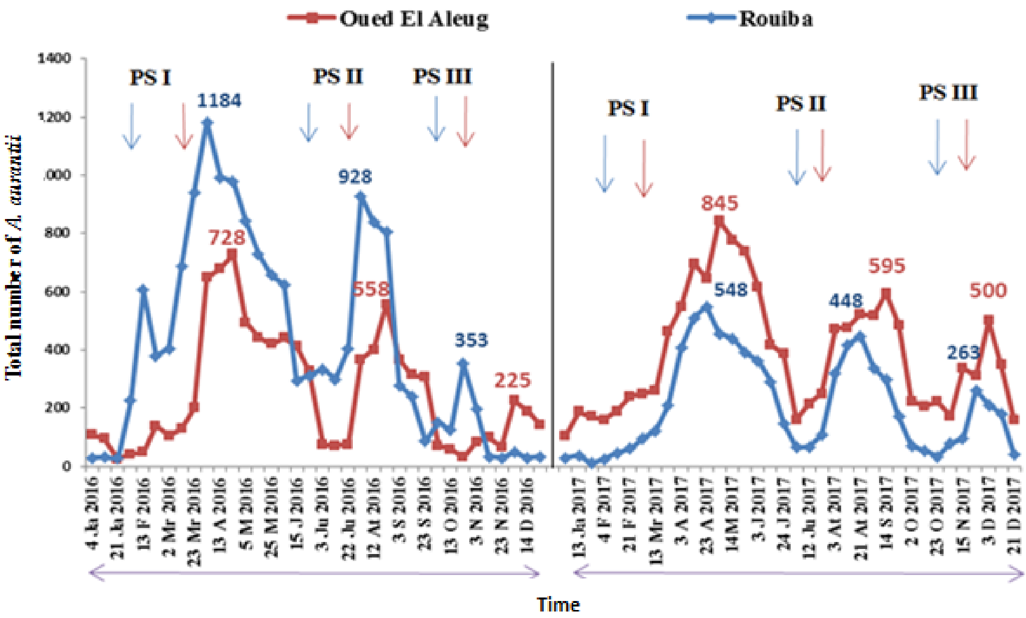

FIG. 2.: Fluctuation in global population numbers of *A. aurantii* on orange trees in Rouïba and Oued Alleug from January 2016 to December 2017.

In 2016, the first peak of the overall populations was noted on April 2 with 1184 individuals in Rouïba and on April 22 with 728 individuals in Oued Alleug for the first generation. The second peak was noted on August 3 with 928 individuals in Rouïba and on August 21 with 558 individuals in Oued Alleug. The last peak was recorded on October 23 with 353 individuals in Rouïba and on December 3 with 225 individuals in Oued Alleug.

As for the year 2017, we noticed a first total population peak on April 23 with 845 individuals in Rouïba and on May 4 with 548 individuals in Oued Alleug for the first generation. The second population peak was noted on August 21 with 448 individuals in Rouïba and september 14 with 595 individuals in Oued Alleug. The last peak was recorded on November 23 with 263 individuals in Rouïba and on December 3 with 500 individuals in Oued Alleug.

Population distribution by plant organ

The red scale on orange trees prefers to settle on the branches than on the leaves. Indeed, we noted in Rouiba a rate of 76.72% in 2016 and 54.80% in 2017 but in Oued Alleug we recorded a rate of 68.67% in 2016 compared to 73.60% in 2017. Although the red scale insect was significantly less present on the leaves, in Rouiba it was found on the upper surface with a rate equal to 12.93% in 2016 while 31.50% in 2017. In Oued Alleug we recorded a rate of 17.63% in 2016 as opposed to 13.54% in 2017. On the underside of the leaves, we noted a low rate that did not exceed 13.70% in the 2 study sites and for the two years of study also (Fig. 3).

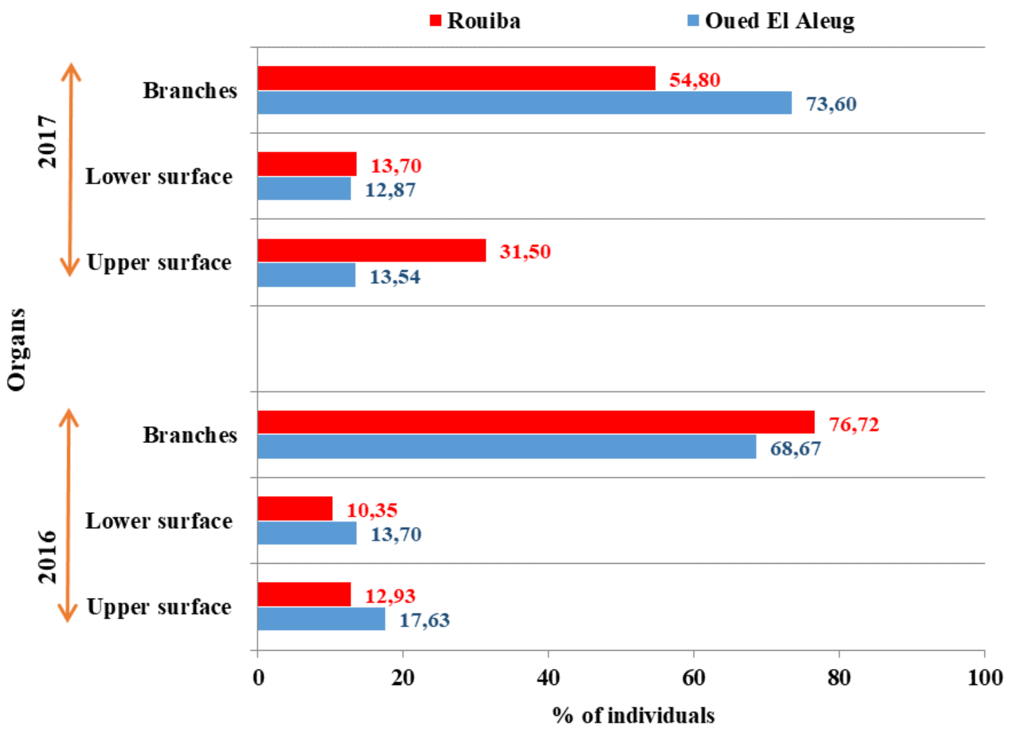

FIG. 3.: Distribution according to plant organ of *A. aurantii* populations on orange trees in Rouïba and Oued Alleug from January 2016 to December 2017.

Cardinal distribution

The center of the tree was the most affected by this scale. Indeed, we noted in Rouïba a rate of 57.31% in 2016 and 30.13% in 2017 while in Oued Alleug we recorded a rate of 44.58% in 2016 and 67, 81% in 2017. This location seems to be a preferential place for this scale insect in both sites and for both years of study (Fig. 4).

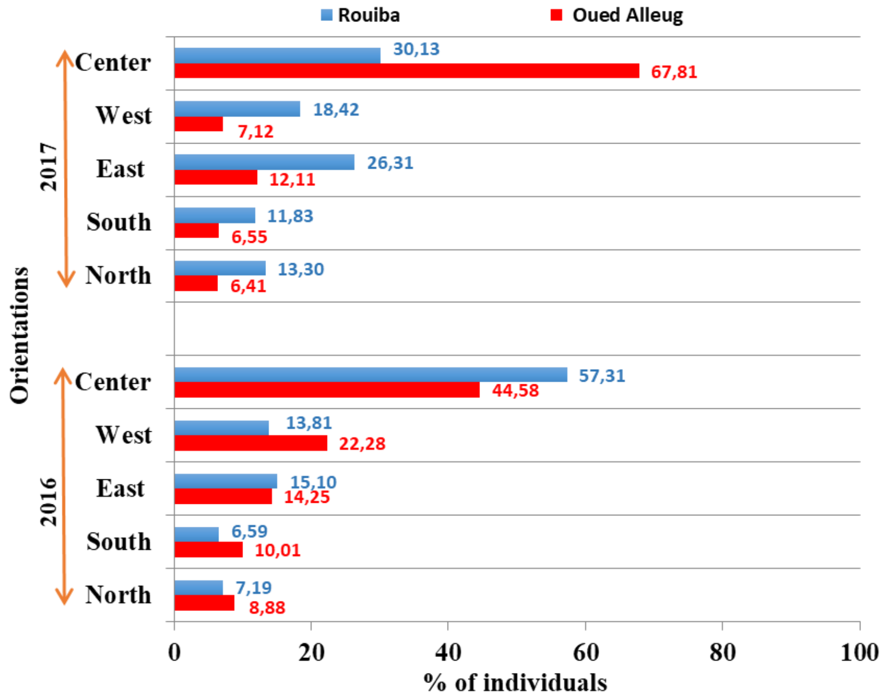

FIG. 4.: Cardinal distribution of *A. aurantii* populations on orange trees in Rouïba and Oued Alleug from January 2016 to December 2017.

Seasonal distribution of crawlers (mobile larvae) according to cardinal orientations

The seasonal distribution of crawlers of *A. aurantii* according to orientations showed identical behavior on orange trees, in both study sites and in both years (Fig. 5).

In autumn, the center of the tree represents the most desired place by the mobile larvae for the fixation with percentages higher than 54.93% in Rouiba and higher than 34.51% in Oued Alleug for both years. In winter, the population continues its migration towards the center of the tree to mark percentages higher than 54% in Rouiba and higher than 43.51% in Oued Alleug and low percentages on the other orientations. In spring, when the climatic conditions become more favorable, the mobile larvae migrate from the center of the tree to the east of the tree to mark percentages higher than 64.22% in Rouiba and higher than 28.16% in Oued Alleug followed by the center. In summer, the summer population continues its migration towards the east of the tree to mark a percentage that exceeds 28.80%.

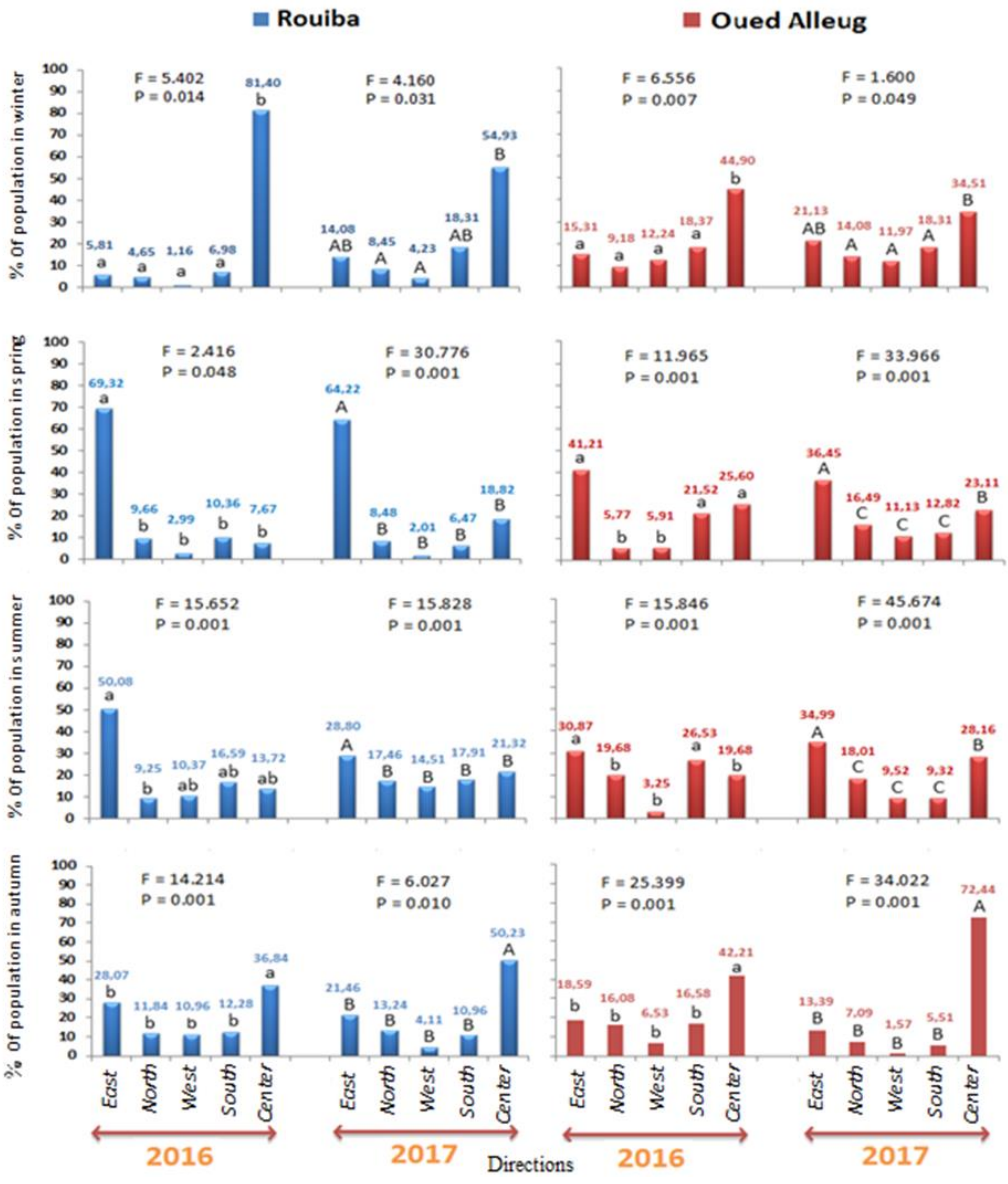

FIG. 5.**:** Cardinal distribution of *A. aurantii* populations on orange trees in Rouïba and Oued Alleug from January 2016 to December 2017.

In addition, ANOVA analyses revealed that cardinal directions of the tree are statistically significant, influenced the distribution of mobile larvae of *A. aurantii* on orange trees, in both regions and both years of study. In winter, the insects significantly preferred the center, followed by the southern directions of the trees. The spring season showed a migration of *A. aurantii* from the center to the east.

A similar pattern to that of spring was observed in summer. In the fall, the insects also migrated to the center of the trees.

For all seasons, the western orientations remained the least desirable. The center of the trees gave the insect the best microclimatic conditions for its development. This only implies that effective and efficient control of *A. aurantii* in winter and summer requires careful application of insecticides in the center of trees.

Study of overall fecundity

The reading of the results of the average fecundity shows that there are three periods of laying which coincided mainly with the three sap flushes of the plant in the two sites and for the two years of study: a spring, a summer and an autumn laying. The first one presents important averages and lasts from four to five months approximately. The second with less important averages and lasts approximately three months. The third one, on the other hand, lasts only two months with smaller averages (Fig. 6).

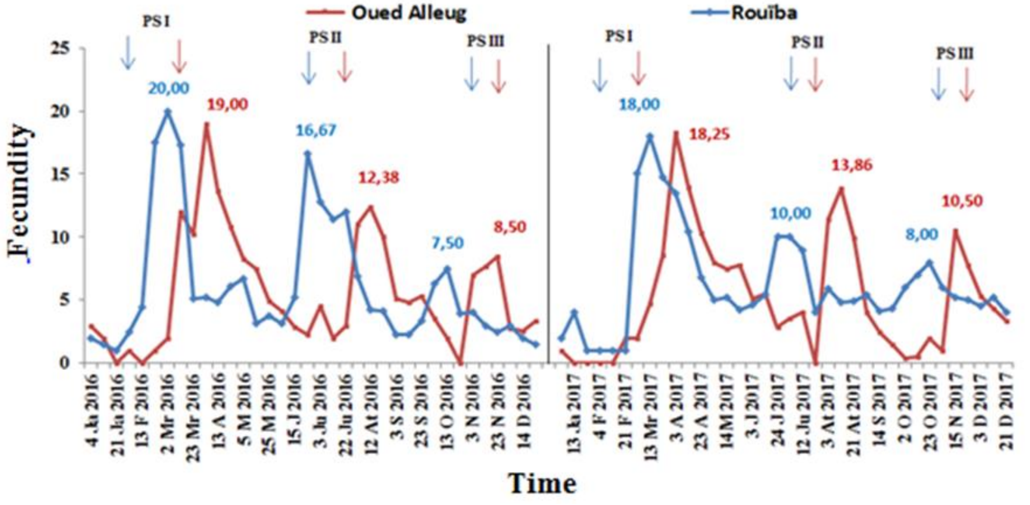

FIG. 6.**:** Average fecundity in A. aurantii on orange trees in Rouïba and Oued Alleug from January 2016 to December 2017.

Furthermore, we noted a time lag in the average fecundity of *A. aurantii*. The three periods of activity in Oued Alleug started a little late compared to those in Rouïba. We noted a shift of 33 days (in 2016) and 21 days (in 2017) for the first generation, 18 days (in 2016) and 17 days (in 2017) for the second and 41 days (in 2016) and 23 days (in 2017) for the third.

In 2016, the first period of oviposition in Rouïba started in the first ten days of February, which coincided with the first flush of sap and ended towards the end of March where the first peak of fecundity was noted on March 2 with an average of 20 larvae / female. The second oviposition started during the first ten days of June and ended around the beginning of September where the peak was noted on June 24 with an average equal to 16.67 larvae/female. The third oviposition began during the second ten days of September and ended by the end of December. The last peak of egg laying was recorded on October 13 with a rate of 7.50 larvae/female.

On the other hand, in Oued Alleug the first period of oviposition, began during the second ten days of February and ended towards the end of June with a peak noted on April 4 with a maximum average equal to 19 crawler /female. The second oviposition began in the second decade of June and ends on October 21. The second peak was noted on August 12 with an average equal to 12.38 crawler /female. Finally, the third peak began in late October and ended in late December. The last peak was on November 23 with an average of 8.50 larvae/female.

In 2017, the first period of oviposition of the red scale insect in Rouïba began around the last ten days of February and ended by the end of March passing by the first peak on March 13 with an average equal to 18 crawler/female. The second oviposition started during the first ten days of June and ended by the end of September. The second peak was recorded on June 24 with an average of 10 crawler/female. Finally, the third period of egg laying began during the second ten days of September and ended towards the end of December with a peak on 23 October with an average of 8 crawler/female. But in Oued Alleug the first period of spawning, began towards the end of February and ended towards the end of July and the peak of fecundity was noted on April 3 with an average equal to 18.25 crawler/female. While the second spawning began during the first ten days of August and ended on October 15, the second peak was on August 11 with an average equal to 13.86 crawler/female. The third spawning started towards the end of October and ended by the end of December and the last peak was reached on November 15 with an average equal to 10.50 crawler/female. The average values of fecundity varied from 1 to 20 crawlers/female in Rouïba. While in Oued Alleug it varied from 0 to 19 crawler/female.

The results of the analysis of variance (ANOVA) show that the effect of the factor "Date" on the fecundity of *A. aurantii* has a very highly significant effect for ($p < 0.0001$) and a significant effect for the factor region ($p = 0.0269$).

Discussion

The *A. aurantii*’s number of generations that have been studied on orange trees, over two years; 2020, 2021, in Rouiba and Oued Alleug regions, Algeria, were three annual generations, one in each of spring, summer and fall. Our results confirm those reported by Biche et al. (2012) and Belguendouz (2014). El Kaoutari et al. (2004) and Belguendouz et al. (2013) stated that the California Red Scale, has a very variable number of generations, largely influenced by the climatic conditions of the region, particularly the temperature and precipitation levels.

The California Red Scale insect has a great capacity for adaptation to climatic variations (Belguendouz et al., 2013). In certain regions of the world, the number of *A. aurantii* generations can reach up to seven per year. In the Tadla region, Morocco, El Kaoutari et al. (2004) noted that this insect has developed four generations. In South Africa, this armored scale insect is present throughout the year, developing four annual generations and up to seven in sunny environments (Bedford, 1998). Grout and Richards (1989), by using sex pheromone traps, recorded four to six generations / year on orange trees and five to seven generations / year on lemon trees. According to Miller and Davidson (1990), the California Red Scale has scored two to three generations per year in California, six in Argentina and four in Cyprus. Asplanato et al, (2002), noted three *A. aurantii* generations in Uruguay. In Italy, Tumminelli et al, (1996) observed between three and five generations as well as in Spain (Pekas, 2010).

During our observations, it was possible to discover a continuous presence of the various insect stages throughout the entire year, which was due to the overlapping generations resulting from the continuous emission of crawler by the females. Indeed, El Kaoutari et al. (2004) and Biche (2012) asserted that the A. aurantii generations are all overlapping. In the present study, we found that the larval stages and adult females were the most predominant stages in Cochineal populations, this current result was agreement with that of Boutaleb and El Hardouni, (2011).

The adult female stage was the most resistant, especially at low temperatures and heavy precipitation, because of their thick shield and their body's encystment. Our findings were similar to those of Benassy and Bianchi (1974), who found that the overwintering stages of *A. aurantii* include the second stages and the adult females. According to El Kaoutari et al. (2004), an increase in temperature stimulates the resumption of activity of the overwintering stages. It is only in summer that the biological activity is optimal, and these results are consistent with those shown by Belguendouz et al. (2013).

Scale insects always seek out places that provide the best conditions for their development (Biche et al., 2012). Their distribution according to the plant organ and cardinal orientation, as well as their seasonal distribution, is primarily influenced by climatic factors, specifically temperature and precipitation. Carroll and Luck (1984) observed that the California Red Scale locates itself mainly on parts of the tree that contain the highest nutrient content. The obtained results showed that the insect exhibited a marked preference for the center of the tree. Effectively, Biche et al. (2012) and Belguendouz (2014) affirmed that the red scale insect prefers to concentrate much more in this part of the tree, because it searches for the least sunny zones that offer the necessary microclimatic conditions for its development. Additionally, Smirnoff (1950) noted that shade creates favorable microclimatic conditions with very low evaporation and higher humidity, influencing red scale insect population. It is possible that the high abundance of *A. aurantii* populations in the center of the tree may be linked to the influence of shade.

Furthermore, our results showed that this scale insect is more abundant on branches than on leaves. This aligns perfectly with the findings of El Kaoutari et al. (2004), who reported that the branches are the most occupied area by the Cochineal, because they better maintain Cochineal populations. Alongside temperature and humidity, the effects of which have been extensively discussed previously, Abbassi (1980) noticed that light constitutes a third factor that directs the activity of neonate larvae and defines their level of fixation on trees.

Likewise, we observed that spring is the best season for *A. aurantii* proliferation. The results obtained by Biche et al. (2012) in the Rouiba region on lemon trees are similar to ours.

Concerning fertility, the study showed that the slope is much higher during the spring and summer seasons. Stofberg (1937) reported the same result for the California Red Scale, noting that fertility is greater throughout the summer season on orange trees. Contrary to our findings, Bliss et al. (1931) observed that the fertility of *A. aurantii* on lemon trees is higher in the spring.

The statistical analysis demonstrated that orientation, stage, season, and plant organ significantly influence the total population development of *A. aurantii*. As a result, we can infer that light, seasonal climate changes, and nutrient source appear to be limiting factors for the red scale insect development and proliferation, as underlined by several authors (Abbassi, 1980; Biche and Sellami, 1999; and Maher, 2002). These authors have also indicated that the host plant is responsible for numerous bioecological variations in the insect, such as the difference found in the spatiotemporal distribution of *A. aurantii* on the feeding organ, the geographic region, the period of year, and particularly the host plant.

Conclusion

The California Red Scale developed three generations per year; one in spring, one in summer and one in fall. The adult female stage was the most dominant, with a rarity of adult males. The distribution of neonate larvae was a good indicator for understanding the red scale insect behavior, since it is the only mobile stage. As mentioned above, the red scale insect was always looking for areas that ensure its good development, this explains the results we have found. In fall and winter, the larvae were more abundant in the center of the tree, while in spring and summer they migrated towards the east direction of the trees, seeking more favorable microclimatic conditions, notably temperature and luminosity.

The branches were the preferred location for the red scale insect to attach, rather than the leaves. Fertility has been influenced by ecological factors. Larvae are emitted throughout the year, resulting in overlapping generations. According to our results, shaded areas promoted higher fertility. Fertility was higher in the center of the tree, on the lower side of the leaves, and on the branches. It is also noted to be higher in spring and summer compared to other seasons.

References

Abbassi, M., 1980 - Recherche sur deux homoptères fixés des Citrus, *Aonidiella aurantii* Mask. (Homoptera : Diaspididae) et Aleurothrixus floccosus Mask (Homoptera: Aleyrodidae). Thèse de docteur de spécialité, Unité de la recherche de science naturelle de l'Université de Provence, pp : 16-73.

Asplanato, G. and Garcia-Marí, F., 2002 - Parasitismo de la cochinilla roja californiana *Aonidiella aurantii* (Homoptera: Diaspididae) en la zona citrícola de Uruguay. Boletín de Sanidad Vegetal-Plagas, 28, pp : 5-20.

Bedford, E.C.G., 1998 - Red scale *Aonidiella auranii* (Maskell). In: E.C.G. Bedford, M.A. Van den Berg and E.A. De Villiers (eds.), Citrus pests in the Republic of South Africa. Dynamic Ad., Nelspruit, South Africa, pp: 132-134.

Belguendouz, R., 2014 - Relations plantes hôtes cochenilles diaspines sur les agrumes (*Citrus* sp.) en Algérie: cas de *Parlatoria ziziphi* (Lucas, 1853) (Homoptera: Diaspididae). Thèse Doctorat, Ecole Nationale Supérieure Agronomique, El Harrach (Alger), 265 p.

Belguendouz, R., Biche, M., Adda, R. and Benfekih, A.L., 2013 - Bioecology of a Citrus pest (*Aonidiella aurantii* Maskell) (Hemiptera, Diaspididae). American-Eurasian Journal of Sustainable Agriculture, Algérie, 7(1), pp: 14-20.

Benassy, C. and Bianchi, H., 1974 - Observation sur *Aonidiella aurantii* Mask., et son parasite indigène *Comperiella bifasciata* How. Bull. SROP, 3, pp: 39-50.

Biche, M., 2012 - Les principaux insectes ravageurs des agrumes en Algérie et leurs ennemis naturels. Ed. FAO., Regional Integrated Pest Management Programme in the Near East / GTFS/REM/070/ITA, 36 p.

Biche, M. and Sellami, M. (1999) - Etude de quelques variations biologiques possibles chez *Parlatoria oleae* (Colvée) (Homoptera, Diaspididae). Bulletin de la société entomologique de France, 104(3), pp : 287-292.

Biche, M., Agagna, Y., Belouad, N. and Gueddada, F., 2016 - Rôle d'*Aphytis melinus* (Hym. Aphelinidae) et *Comperiella bifasciata* (Hym. Encyrtidae) dans la limitation du Pou de Californie *Aonidiella aurantii* (Hom : Diaspididae) sur agrumes en Algérie. Séminaire International «Santé des plantes au service du développement» Institut des Sciences Agronomiques, Univ. Hassiba Ben Bouali de Chlef, les 12, 13 et 14 avril 2016.

Biche, M., Siafa, A., Adda, R. and Gherbi, R. 2012 - Biologie d'*Aonidiella aurantii* (Homoptera, Diaspididae) sur citronnier dans la région de rouiba. Lebanese Science Journal, 13, pp: 59-64.

Bliss, C.I., Broadbent, B.M. and Watson, S.A., 1931 - The life history of the California red scale *Chrysomphalus aurantii* Maskell: Progress Report. Journal of Economic Entomoogy, 24, pp: 1222-1229.

Boutaleb, J. and El Hardouni, A.I., 2011 - Monitoring of the California red scale *Aonidiella aurantii* (Maskell), the Tetranychid mites and their natural enemies on *Citrus* fruits in the Gharb area (Morocco) Integrated Control in Citrus Fruit Crops IOBC/wprs Bulletin Vol. 62, 105 p.

Carroll, D.P. and Luck, R.F., 1984 - Within-tree distribution of California red scale, *Aonidiella aurantii* (Maskell) (Homoptera: Diaspididae), and its parasitoid *Comperiella bifasciata* Howard (Hymenoptera: Encyrtidae) on orange trees in the San Joaquin Valley. Environmental Entomology, 13(1), pp: 179-183.

El Kaoutari, I., Guirrou, Z., Chemseddine, M. and Boumezzough, A., 2004 - Rôle d'*Aphytis melinus* (Debach) dans le contrôle naturel d'*Aonidiella aurantii* (Maeskell) en verger d'agrumes au Maroc. Fruit, 59 (3), pp:169-179.

Food and Agriculture Organization, 2013 - La production des agrumes dans le monde, Banc des données statistiques, F.A.O.STAT. http//www.fao.org. Consulter le 10/02/2017

Grout, T. and Richards, G. I., 1989 - California red scale (Homoptera: Diaspididae) phenology on citrus in South Africa. Journal of Economic Entomology, 82, pp: 793-798.

Jacquemond, C., Curk, F. and Huzet, M., 2013 - Les clémentiniers et autres petits agrumes. Ed.Quae, France, pp : 17- 66.

Koutti, A and Bounaceur, F., 2013 - Study of damage of thrips on citrus orchards of Mitidja, Alegria. Ed angewandten biologie forschung, 1 (3), pp: 35-42.

M.A.D.R., 2015 - Donnés statistique du ministère de l'agriculture et de développement rural, Alger, 3 p.

Maher, N., 2002 - Sélection du site de ponte chez *Lobesia botrana* (Lepidoptera, Torticidae): influence de l'information chimique non volatile présente sur les fruits de plante hôtes. Th. Doct. Sc. Biol. Med., Univ. Bordeaux 2 (France), 125 p.

Miller, D.R. and Davidson, J.A., 1990 - A list of the armored scale insect pests. In: Armored scale insects. Their biology, natural enemies and control, Vol. 4A. Rosen, D., (Ed.), Elsevier, Amsterdam, Oxford, New York, Tokyo, pp: 299-306.

Pekas, A., 2010 - Factors affecting the biological control of California red scale *Aonidiella aurantii* by *Aphytis* in eastem Spain Citrus: host size,ant activity,and adult parasitoid food sources.Universidad Politécnica de Valencia. Doctoral Thesis, 146 p.

Quilici, S., 1993 - Les ravageurs des agrumes. In: Lutte intégrée contre les ravageurs descultures pérennes tropicales, Dominique M.ED. Réunion CIRAD, pp : 73-111.

Quilici, S., Vincenot D. and Franck A. (2003) - Les auxiliaires des cultures fruitières à l'île de La Réunion. France: CIRAD -

Chambre d'Agriculture de la Réunion. 168 p.

Smirnoff, W., 1950 - Sur la biologie au Maroc de *Rhizobius lophantae* Blaisd. (Col. Coccinelidae). Revue de pathologie végétale et d’entomologie agricole de France, 29, pp: 190-194.

Stofberg, F.J., 1937 - The Citrus red scale (*Aonidiella aurantii* Mask.). Union of South Africa, Department of Agriculture and Forestry, Science Bulletin, n° 31, pp: 167-224.

Tumminelli, R., Conti, F., Saraceno, F., Raciti, E. and Schiliró, R., 1996 - Seasonal development of California red scale (Homoptera: Diaspididae) and *Aphytis melinus* DeBach (Hymenoptera: Aphelinidae) on *Citrus* in Eastern Sicily. Proceedings International Society of Citriculture, 1, pp: 642-648.

Vasseur, A. and Schvester, D., 1957 - Biologie et écologie du pou de San José (*Quadraspidiotus perniciosus*) en France, Annales des Epiphyties et de Phylogénétique, Institut National de Recherche. Agronomique, Paris, 65, pp : 5-161.

Walker, G.P., Zareh, N. and Arabaia, M.L., 1999 - Effect of pressure and dwell time on efficiency of a high-pressure washer for postharvest removal of California red scale (Homoptera, Diaspididae) from citrus fruit, J. Econ. Entomol. 92 (4), pp: 906–914.

Επίδραση της γεωγραφικής περιοχής και της ροής του χυμού της πορτοκαλιάς στη δυναμική των πληθυσμών του *Aonidiella aurantii* (Hemiptera: Diaspididae) στη Mitidja (Αλγερία)

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ΠΕΡΙΛΗΨΗ

Στόχος αυτής της εργασίας ήταν να μελετήσει την επίδραση της γεωγραφικής περιοχής και της ροής του χυμού σε ορισμένες βιοοικολογικά χαρακτηριστικά του *Aonidiella aurantii* (Maskell) (Hemiptera: Coccomorpha: Diaspididae). Η παρακολούθηση του βιολογικού κύκλου του *A. aurantii* διεξήχθη με τακτική καταγραφή των σταδίων ανάπτυξής του σε διαφορετικά φυτικά μέρη των δένδρων, όπως κλάδους και φύλλα κατά τη διάρκεια δύο διαδοχικών ετών (2017 και 2018) στις περιοχές Rouiba [36°44′00′ 'N; 3°17′00″E] και Oued El Alleug [36°44′00″N; 3°17′00″ A]. Η μελέτη της δυναμικής του πληθυσμού έδειξε ότι στην πορτοκαλιά, στις περιοχές Rouiba και Oued Alleug, το είδος αναπτύσσει τρεις γενεές / έτος, οι οποίες χρονικά συμπίπτουν με τις αντίστοιχες τρεις αυξήσεις την κινητικότητας του φυτικού χυμού των δένδρων: άνοιξη, καλοκαίρι και φθινόπωρο. Η περίοδος της άνοιξης είναι η πιο ευνοϊκή για την ανάπτυξη του εντόμου. Επιπλέον, έχει πολύ έντονη τάση συγκέντρωσης προς το εσωτερικό και τους κλάδους του δέντρου, που του εξασφαλίζουν καταλληλότερες συνθήκες για την ανάπτυξή του. Όπως και σε άλλα είδη, η χρονική εμφάνιση της κάθε γενεάς εξαρτάται από τη γεωγραφική θέση των φυτών ξενιστών (απόσταση από τη θάλασσα) αλλά και από την κινητικότητά των φυτικών

χυμών. Διαπιστώθηκε ότι οι τρεις περίοδοι εντονότερης δραστηριότητας του εντόμου στην περιοχή Oued Alleug ξεκίνησαν λίγο αργότερα από ότι στην περιοχή Rouïba. Το φθινόπωρο και τον χειμώνα, οι έρπουσες του κοκκοειδούς καταγράφονται κυρίως στο κέντρο της κόμης του δέντρου, ενώ την άνοιξη και το καλοκαίρι εγκαθίστανται κυρίως στην ανατολική πλευρά της, όπου οι συνθήκες για την ανάπτυξή τους είναι πιο ευνοϊκές. Οι μέσες τιμές γονιμότητας κυμάνθηκαν από 1 έως 20 έρπουσες/θήλυ στην περιοχή Rouïba, ενώ στην περιοχή Oued Alleug, από 0 έως 19 έρπουσες/θήλυ. Η ανάλυση διακύμανσης δείχνει ότι οι παράγοντες έτος, μήνας και περιοχή προκάλεσαν σημαντικές διαφορές ($p<0,0001$) στη βιολογία του εντόμου κατά την περίοδο της μελέτης στις περιοχές Rouïba και Oued Alleug, με πιθανότητα ($p<0,0001$). Η κατανομή των ερπουσών απετέλεσε έναν καλό δείκτη για την κατανόηση της συμπεριφοράς του κοκκοειδούς. Τα ευρήματα αυτής της μελέτης έχουν πολύ μεγάλη σημασία για τον έλεγχο του κοκκοειδούς εντόμου *A. aurantii*.

