STUDIA UNIVERSITATIS BABEŞ-BOLYAI BIOLOGIA, 65, 1, 2020 (p. 19-28)
doi:10.24193/subbbiol.2020.1.02

Diversity of aphids (Hemiptera: Aphididae) in oases agro-ecosystem: seasonal dynamics and host plants

Nacima Deghiche Diab[1,2,3]✉, Lahcen Deghiche[1,2] and Mohammed Belhamra[1,2,3]

[1] *Agronomic Department, University of Mohammed Khaider, Biskra, Algeria;*
[2] *Laboratory of Ecosystem Diversity and Dynamics of Agricultural Production Systems in Arid areas, University of Mohammed Khaider, Biskra, Algeria;*
[3] *Center for Scientific and Technical Research on Arid Regions (CRSTRA);*
✉ ***Corresponding author, E-mail: diab_nassima@yahoo.fr.***

Abstract. During the study conducted at the palm grove of Ziban oases from June 2017 until May 2018 and from 48 samples yellow water traps, a total of 969 aphids specimens were captured from 36 spontaneous plants identified at Ain Ben Noui palm grove, Biskra. Over 11 aphid species were identified, which 5 were qualified as accidentals and 3 were respectively accessories and constant species. The most abundant species were *Myzus persicae* (26.32%) and *Aphis gossypii* (21.05%). *Myzus persicae* (Sulzer, 1776) was observed on 9 spontaneous plants, *Aphis fabae* (Scopoli, 1763) was associated to 12 spontaneous plants, whereas *Aphis craccivora* (Koch, 1854) was recorded on 6 spontaneous plants. The most important richness of winged aphids in palm grove was recorded during the spring season (April = 65 individuals; March = 58 individuals) where temperature average was between 17.5°C, 25°C and level rains (May=49.53mm; March=11.67mm).

Key words: Aphids, Biskra, diversity, host plants, palm groves.

Introduction

Aphids belonging to Insecta class, Hemiptera order, Aphididae family, encompass about 4700 species in the world (Remaudière and Remaudière, 1997; Blackman and Eastop, 2000). Their ecology presents a particular phenomenon, winged that constitutes the dispersal form and skills form specialized in colonization of plants. Because aphids have a good biological model for habitat selection (Pettersson *et al*., 2007), in addition host plants have a great impact on their diversification, aphids follows an annual cycle between a primary host (cultivated crops) and a secondary host (spontaneous plants). Spontaneous plants are favoured secondary hosts during bad times and in absence of crops

(Guzand Kilincer, 2005). Oases ecosystems are favourable home of wild flora associated to cultivated vegetation that occupy up to three levels (Diab and Deghiche, 2013; 2016, Deghiche-Diab, 2015). In order to have an idea about aphid population that inhabit oasis ecosystem, this study have for objective to assess the diversity of aphids, abundance and their habitats diversity according to wild plants.

Material and methods

Study area

Located in the municipality of El Hadjeb, at 8 km west of the capital of Biskra province, Ain Ben Noui (34° 48 '21.68' 'N and 05 ° 39'24.72' 'E) palm grove is a part of the experimental station of the Technical Institute for Saharan Agriculture Development (Fig. 1), it covers an area of 21.5 hectares. Situated in an arid area, the period of study was characterized by cumulative precipitation 49.25mm, the average of the maximum temperature 28.9°C and the minimal temperature 17°C (www.tutiempo.net).

Figure 1. Plot survey and pitfall traps location in palm grove (Google earth).

Sampling methods

Our survey was performed from the same sampling areas for both aphids and spontaneous plants but obviously applying different protocols. Aphids were sampled weekly using 3 yellow traps placed in diagonal and spaced far enough to collect specimens (Benkhellil, 1991). Visual observations of spontaneous plants were performed from 4 belt transect (Holt *et al*., 2013) with 50m length

and escaped 50m (Fig. 1). Collected specimens were separated using magnifier binocular in laboratory. Samples were identified to genus and species for the majority specimens. They were stored in collection boxes and kept in the entomology laboratory.

Ecological Analysis

To characterize aphids and host plants from spontaneous plants in Ziban palm groves, we use of environmental indices; total wealth (S) and average (Sm = Σ S / N) (Ramade, 1983), the relative abundance (AR or F = 100 or x /N) (Dajoz, 1971), density (D=N/P) Occurrence and Dominance (Dajoz, 1985), Shannon index (H '= $\log_2$ -Σ pi) (Blondel, 1973) and evenness ($E = \frac{H\prime}{H\prime_{max}} = \frac{H\prime}{\log 2S}$) for both (Blondel, 1975). To describe aphid species captured we also classified aphid species according to their host specificity. Data on species structure, abundance, diversity and differences in community composition at each month were analysed using PAST (Paleontological Statistics; Version 2.17) software. The relationships between insect diversity parameters were verified using Pearson correlation tests for each month.

Results and discussions

Aphid diversity and abundance

During the trapping season over 48 weeks, 969 individuals aphids were collected, including 11 genera and 11 species (Tab. 1)**.** The study reveals the presence of 11 species of winged aphids distributed in one family (Aphididae), 1 (one) subfamily (Aphidinae) and 2 (two) tribes. With regard to the tribes listed, it appears that Aphidini tribe was best represented (6 species) in palm groves, whereas Macrosiphini tribe was represented with 5 species (Tab. 1). Aphis genus was the most represented in different sites in palm grove with 4 species followed by *Rhopalosiphum* genus with only 2 species, the other genus were represented only with 1 species for each.

Results of few studies carried out across Biskra region indicate a richness that oscillates between 3 species (Saighi *et al*., 2005), 18 species (Ben Abba and Bengouga, 2007) and 30 species (Laamari *et al*., 2010). In total, from latest survey at Ziban palm groves: Menacer (2012), Deghiche Diab (2009), Deghiche et *al*., (2015), Deghiche Diab et *al*. (2015a,b) and Deghiche *et al*., (2020) listed 33 species of aphids in Ziban oases. The most represented aphid species in oasis ecosystem were (Fig. 2): *Myzus persicae* Sulzer, 1776 (26.32%), *Aphis gossypii* Glover, 1877 (21.05%), *Brachycaudus helichrysi* Kaltenbach, 1843 (19.9%.) and *Aphis fabae* Scopoli, 1763 (10.22%). Those represented with less diversity were; *Rhopalosiphum maidis* Fitch, 1856 (1.14%), *Aphis nerii* Fonscolombe, 1841 (1.55%) and *Uroleucon sonchi* Linnaeus, 1767 (2.37%).

Table 1. Aphid species collected from Ziban palm grove (2017-2018).

Family	Sub-family	Tribes	Genus	Species
Aphididae	Aphidinae	Aphdini	*Aphis*	*Aphis craccivora* Koch, 1854
				Aphis fabae Scopoli, 1763
				Aphis nerii Fonscolombe, 1841
				Aphis gossypii Glover, 1877
			Rhopalosiphum	*Rhopalosiphum maidis* Fitch, 1856
				Rhopalosiphum padi Linnaeus, 1758
		Macrosiphini	*Brachycaudus*	*Brachycaudus helichrysi* Kaltenbach, 1843
			Brachyunguis	*Brachyunguis harmalae* B. Das, 1918
			Hyperomyzus	*Hyperomyzus lactucae* Linnaeus, 1758
			Myzus	*Myzus persicae* Sulzer, 1776
			Uroleucon	*Uroleucon sonchi* Linnaeus, 1767

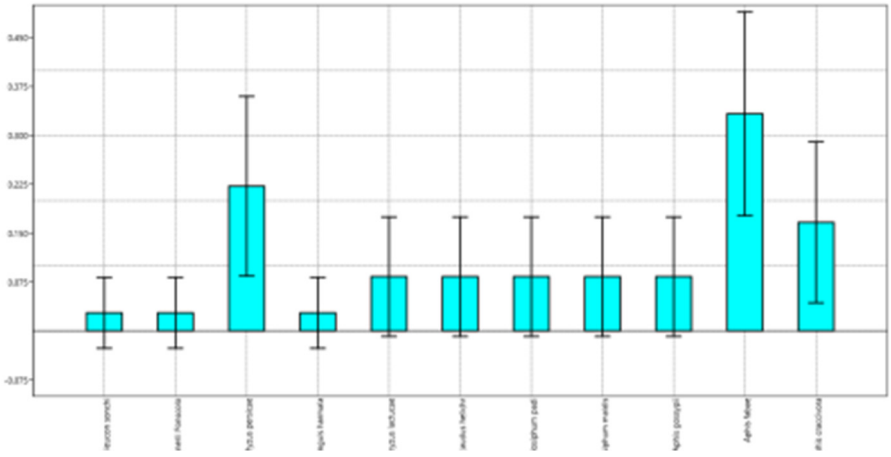

Figure 2. Aphid species richness under Ziban palm groves.

The presence of those species as indicated Robert & Rouze-Jouan (1976) can be related to several factors and parameters gathered in a single environment such as our oasis system, climatic (temperature, humidity) or biological (host plants and the parasite procession).The height number of *Aphis gossypii, Myzus persesea* in palm grove were also indicated during three years of study by Deghiche Diab *et al*., (2015a), Deghiche-Diab *et al*., (2015b) worked in oases of Ziban. Moreover, Menacer (2012), found higher rates of *Myzus persicae* species and *Aphis gossypii*.

Another study, Ghalbi and Mouada (2008), carried out on a field of barley and beans in Sidi Okba region (Biskra), note high rates of *Hyperomyzus lactucae, Myzus persicae* and *Aphis craccivora* species among the 7 species collected.

Constancy

Obtained results on constancy analyses indicate that *Aphis fabae* (Scopoli 1763) *Aphis gossypii* (Glover 1877) and *Myzus persicae* (Sulzer1776) were classified as constants species, whereas *Aphis craccivora* (Koch 1854), *Rhopalosiphum maidis* (Fitch, 1856), *Brachyunguish armalae* (B.Das, 1918), *Aphis nerii* (Fonscolombe, 1841) and *Uroleucon sonchi* (Linnaeus, 1767) were accidental species, identified in our study (Fig. 3) and also reported by Frah (2009) in apple orchards in Batna. Species *Rhopalosiphum padi* (Linnaeus, 1758), *Brachycaudus helichrysi* (Kaltenbach, 1843) *Hyperomyzus lactucae* (Linnaeus, 1758) were accessories species in palm groves (Fig. 3).

The large presence of constant species in palm grove can be explained by polyphagous species living on large number of cultivated species and hosts plants belonging to different wild flora families (Hullé *et al*., 1999; Evelyne *et al*., (2011), from which *Myzus persicae* only have about 875 secondary host plants. Of these is highlighted *Rhopalosiphum padi*, one of the accessory species, because their presence can be related to the senescence of wild grasses responsible for the massive formation of these emigrant adults and cultivated barley plots in palm groves. During our survey rare species were not found, which could be a result of the sampling design (borders were avoided).

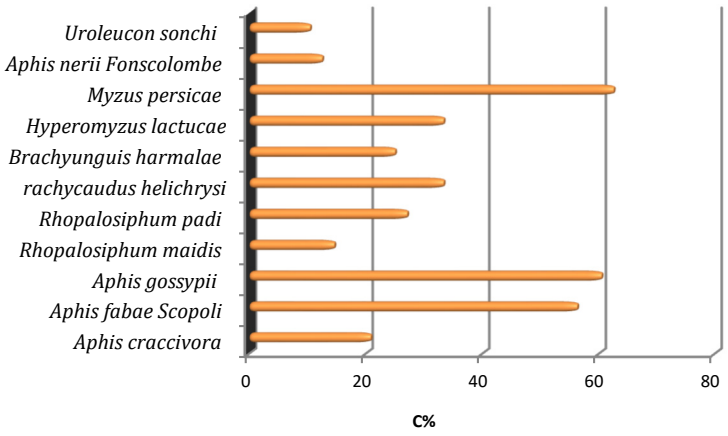

Figure 3. Constancy scale of aphids collected in palm groves.

Shannon diversity index

Value of Shannon diversity index (2.19 bits) calculated for sampled species in palm groves with yellow traps was considered high (Tab. 2); it means that palm groves had height diversity of aphid species. The evenness value (0.63) calculated showed equilibrium with aphid species between them.

Table 2. Total wealth, Shannon diversity index and evenness value for aphid species in palm groves.

Wealth (S)	Evenness value (E)	Shannon diversity (H')	**H MAX**
11	**0.63**	**2.19**	**3.45**

A total of 34 associations were established with 11 species of aphids and 36 spontaneous plants found under palm groves agro-ecosystem (Fig. 4). The largest number of associations were recorded with *Aphis fabae* (12 associations) and *Mysus persicae* (9 associations), followed by *Aphis craccivora* (6 associations) and *Brachycaudus helichrysi* (4 associations) wheels, *Aphis gossypii*, *Rhopalosiphum padi* and *Rhopalosiphum maidis* (3 associations), *Hyperomyzus lactucae* (2 associations), *Aphis nerii*, *Uroleucon sonchi* and *Brachyunguis harmalae* (1 association).

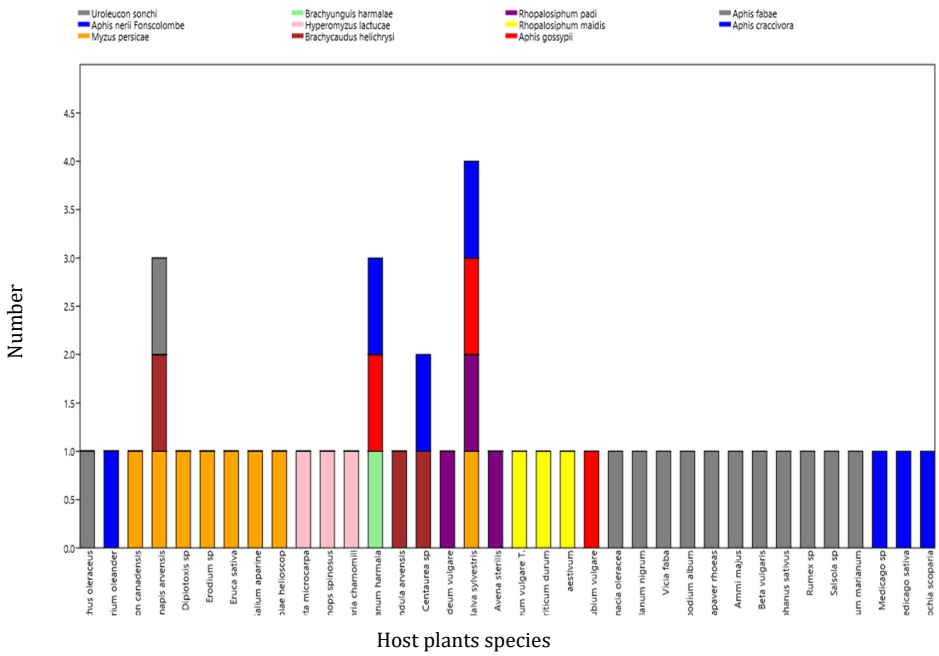

Figure 4. Aphid species association according to their host plants.

According to Hullé *et al*. (1999), *Hyperomyzus lactucae* found in the Mediterranean region is a holocyclic and diocidal aphid. Its secondary hosts are mostly from *Sonchus* genus Asteraceae family, whereas *Aphis craccivora* can be found on species belonging to different families from Asteraceae, Cucurbitaceae, Fabaceae and Solanaceae family (Evelyne *et al.,* 2011). In addition our results were confirmed by Hullé *et al*., (1999), as reported that *Aphis fabae* species have above 200 host plants from which species from Fabaceae, Chenopodiceae, Asteraceae, Brassicaceae botanical families. Laamari *et al*., (2011) in study conducted in two types of ecosystem recorded also 16 associated plants to *Myzus persicae*, 15 plant species with *A. fabae* and *A. craccivora* with only 10 plant species in Biskra region.

We analysed aphid species based on their host plant specificity polyphagous (living on plants from different families), oligophagous living on a reduced number of host plants) and monophagous (on plants of the same family) (Resh and Cardé, 2009). The half of recorder aphid species in palm grove were monophagous aphid species with (45.45%), polyphagous species was least-frequently observed (36.36%) and the oligophagous species were represented only by 18.18%. Among the polyphagous aphids collected we remark: *Aphis craccivora, Aphis fabae, Aphis gossypii* and *Myzus persicae.* The monophagous species were *Rhopalosiphum maidis, Aphis nerii, Uroleucon sonchi, Brachyunguis harmalae* and *Hyperomyzus lactucae.* The oligophagous species were; *Rhopalosiphum padi* and *Brachycaudus helichrysi.*

Distribution of aphid species according to climate conditions

The most important richness of winged aphids in palm grove was recorded during spring season with 65 individuals (April) and 58 individuals (March). During this period the temperature average raised 17.5°C, 22.4 and 25°C respectively during March, April and May, during this period the level rains noted was the highest (May= 49.53mm; March=11.67mm) which favours an important vegetative cover (Fig. 5).

Another peak of aphid activity, but less important, was recorded during autumnal period where temperatures were (Sept= 28; Oct= 22.5; Nov= 11.9 °C) and level rain does not exceed 10mm. A very low percentage was recorded during summer period (July=4; August = 0) and autumn (Sept=6). In addition, during our survey, relative humidity average varies between 24.00 and 55.6%. December, January and February were the wettest, while June, July and August were the driest.

Apparently, the important activity of adults during April and May can be attributed to spread of most species in order to settle on cultivated crops or weeds. It can be also related to temperature that had great importance on aphids activity, life cycle, fertility (Robert, 1980), they can reach their maximum development between 18 until 24°C (Leclant, 1970). In addition, as reported

Bouchet *et al*., (1981), aphids were not able to fly below 13 ° C and died below 5 ° C that explain their number decrease during summer and earlier autumn period. Similarly Bonnemaison (1962) noted that frequent rainfall and high relative humidity decrease the fertility of aphids and increase their mortality. Rainfall had less importance on aphid activities (Robert and Rouze-jouan, 1978) the small quantities recorded during spring period did not disrupt the flight activity of adults but their fertility (Bonnemaison, 1962) and can destroy proportion of wingless and adults.

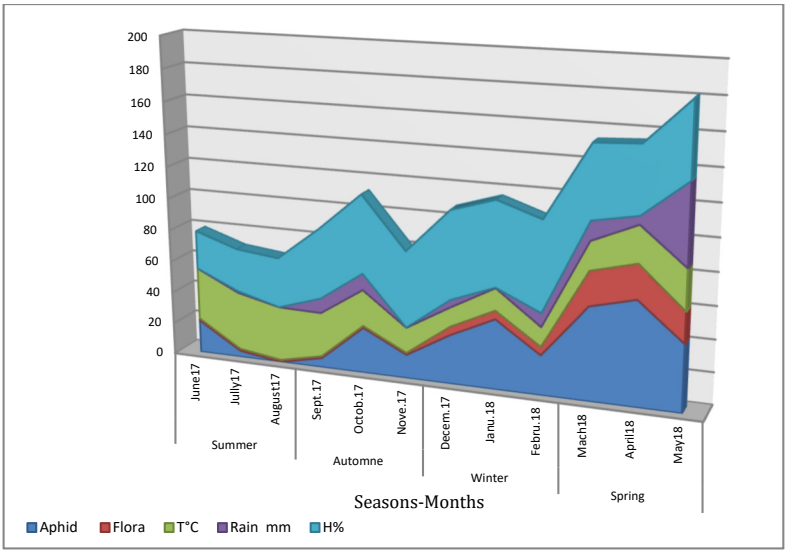

Figure 5. Evolution of aphids and thier host plants according to climat conditions of palm grov during 2017-2018.

Conclusion

At Ain Ben Noui palm grove, 11 aphids species were captured from 36 spontaneous plants identified. The most abundant species were *Myzus persicae* (26.32%) and *Aphis gossypii* (21.05%). *Myzus persicae* (Sulzer, 1776) was observed on 9 spontaneous plants, *Aphis fabae* (Scopoli, 1763) was associated to 12 spontaneous plants, whereas *Aphis craccivora* (Koch, 1854) was recorded on 6 spontaneous plants.

Obtained results from survey conducted in chosen Ziban palm grove for studying dynamic of aphids and their associated host plants, indicate important relations between aphid species and spontaneous flora (weeds, wild flora) inhabiting. Those associations can be useful in future by establishing a program pest control under palm grove.

Acknowledgements. Authors are thankful to personnel of the Laboratory of Ecosystem Diversity and Dynamics of Agricultural Production Systems in Arid areas, University of Mohammed Khider, Biskra, Algeria for their help and determination of species.

REFERENCES

Ben Abba, C., & Bengouga, K. (2007). Contribution à l'étude qualitative des pucerons (Homoptera, Aphididae) sur l'orge et la fève dans la région de Biskra. *Mémoire Ing. Agro., Dép. Agro.*, Univ. Biskra, 100 pp.

BenBenkhelil, M.L. (1991). Les techniques de récolte et de piégeage utilisées en entomologie terrestre. *Ed. OPU* Alger, pp. 66.

Blackman, R.L., & Eastop, V.F. (2000). Aphids on the World's Crops-An identification and information guide*. Ed*. *Ltd JWS and Natural History Museum*, London, pp. 466.

Blondel, J. (1975). L'analyse des peuplements d'oiseaux, éléments d'un diagnostic écologique: la méthode des échantillonnages fréquentiels progressifs (E.F.P.) *Terre et vie* XXIX, 533-589.

Blondel, J. (1979). Biogéographie et écologie, *Ed. Masson*, France, pp. 173.

Blondel, J., Ferry, C., & Frochot, B. (1973). Avifaune et végétation. Essai d'analyse de la diversité. *Alauda*, 4, 63-84.

Bonnemaison, L. (1962). Les ennemis animaux des plantes cultivées et des forêts. Tome II. *Ed. S.E.P*., Paris, pp. 605.

Bouchet, F., Bayou, F., Mouchart, A., Costes, J.P., Lescar, L., Devriendt, M., Dedryver, C. A., Lapierre, H., Moreau, J.P., Chambon, J.P., Brenian, D., Lamessilaire, C., Roque, B., Lechapt, G., & Martin, M. (1981). Les pucerons des céréales à paille. In : *Journées d'étude et d'information sur les pucerons des cultures*, 2,3 et 4 mars 1981, Paris: 117-122.

Dajoz, R. (1971). Précis d'écologie. *Ed. Dunod*, Paris pp. 434.

Dajoz, R. (1985). Précis d'écologie. *Ed. Dunod*, Paris pp. 505.

Deghiche-Diab, N. (2009). Inventory of insects in the oases of Ziban, Biskra- Algeria. Thesis Master of Science, Iam -Bari, Italy. pp. 82.

Deghiche-Diab, N., Deghiche, L., & Belhamra, M. (2015b). Inventory of Arthropods in an agro-ecosystem Ziban oasis, Ain Ben Noui, Biskra, Algeria. *Journal of Entomology and Zoology Studies*. 3(4), 229-234.

Deghiche-Diab, N., Prcelli, F., & Belhamra, M. (2015a). Entomofauna of Ziban oasis. *Journal of Insect Science*. *Oxford*. 15(41).

Deghiche-Diab, N., Belhamra, M., Deghiche, L., & Boultif, M. 2020. Cartography and distrubution of insects species according to habitats diversity in Ziban Biskra-Algeria. *Munis Entomology & Zoology*, 15 (2), 412-421.

Diab, N., & Deghiche, L., (2016). La flore spontanée des Oasis des Ziban*. Éditions Universitaires Européennes*. pp. 300.

Données climatiques: Algérie (2018) [Accessed Dec 2018) *https://fr.tutiempo.net.*

Farah, N. (2009). Entomofaune, impact économique et bio-écologie des principaux ravageurs du pommier dans la régions des Aurès. Thèse Doctorat, Université de Batna. pp. 204.

Google earth V6.2.2.6613.DigitalGlobe . http://www.earth.google.com[DECec, 2018].

Güz, N., & Kılınçer, N. (2005). Aphid Parasitoids (Hymenoptera: Braconidae: Aphidiinae) on Weeds from Ankara, Turkey. *Phytoparasitica*, 33 (4), 359-366.

Hammer, Ø., Harper, D.A.T., & Ryan P.D. (2001). Past: Paleontological Statistics Software Package for Education and. Data Analysis. *Palaeontologia Electronica* http://palaeo-electronica.org.

Holt, B.G., Rioja-Nieto, R., MacNeil, M.A., Lupton, J. & Rahbek, C. (2013). Comparing diversity data collected using a protocol designed for volunteers with results from a professional alternative. *Methods in Ecology and Evolution* 4, 383–392.

Hullé, M., Chaubet, B., Dedryver, C.-A. & Turpeau-Ait Ighil E. (2011). Les pucerons des grandes cultures: Cycles biologiques et activités de vol. *Ed. Quae*, Paris, pp. 36.

Laamari, M., Jousselin, E., & Coeur d'acier, A. (2010). Assessment of aphid diversity (Hemiptera: Aphididae) in Algeria: a fourteen-year investigation. *Entomologie faunistique Faunistic Entomology* 62 (2), 73-87.

Laamari, M., Tahar Chaouche, S., Benferhat, S., Abbès, B.S., Merouani, H., Ghodbane, S., Khenissa, N., & Stary, P. (2011). Interactions tritrophiques: plante-puceron-hyménoptère parasitoïde observées en milieux naturels et cultivés de l'Est algérien. *Entomologie faunistique, Faunistic Entomology* (63)3, 115-120.

Leclant, F. (1970). Les aphides et la lutte intégrée en verger. Bulletin technique d'information. La lutte intégrée en vergers. *Ed. Ministère de l'agriculture*, 249, pp. 261.

Leclant, F. (1981). Les effets nuisibles des pucerons sur les cultures. In : *Journées d'études et d'information. Les pucerons des cultures*. Paris 2, 3 et 4 mars 1981: 37-55

Menacer, S. (2012). Influence des facteurs microclimatiques de la palmeraie sur la diversité du peuplement aphidien dans la région de Biskra. *Mémoire de Magister. Inst. Nat. Agro. El Harrach*. pp. 100.

Pettersson, J. W. F., Tjallingii Hardie, J. (2007). Host-plant Selection and Feeding. Aphids as Crop pests. H. F. van Emden and R. Harrington. Cambridge, CAB International: 87-113.

Ramade, F. (1983). Eléments d'écologie. Ecologie fondamentale. *Ed. Mc Graw-Hill*, Paris. 11, pp. 397.

Remaudière, G., & Remaudière, M. (1997). Catalogue of the world's Aphididae (Homoptera Aphidoidea). *INRA Ed.*, Paris, pp. 473.

Resh, V. H., & Cardé, R. T. (2009). Encyclopedia of Insects, 2nd Ed. pp. 798-800.

Robert, Y. (1980). Recherche sur la biologie et l'écologie des pucerons en Bretagne. Application à l'étude épidémiologique des viroses de la pomme de terre. Thèse doctorat Scie., Rennes, pp. 242.

Robert, Y., & Rouze-Jouan, J. (1976). Activité saisonnière de vol des pucerons (Hom. Aphididae) dans l'ouest de la France. Résultats de neuf années de piégeage. *Ann. Soc. Ent. Fr. (N.S)* 12(4), 671-690.

Robert, Y., & Rouze-Jouan, J. (1978). Recherches écologiques sur les pucerons *Aulocathum solani* Kith., *Macrosiphum euphorbiae Thomas* et *Myzus persicae* Sulz. Dans l'ouest de la France. Etude de l'activité de vol de 1967 à 1976 en culture de pomme de terre. *Ann. Zool. Ecologia Animale*, 10(2), 171-185.

Saighi, S., Doumandji, S., Aifaoui, O., & Haichar, M. (2005). Contribution à l'inventaire de l'entomofaune dans la région de Biskra. In: *Actes des journées internationales sur la désertification et le développement durable*, du 10 au 12 juin 2006. CRSTRA et Univ. de Biskra : 239-248.

Turpeau-Ait Ighil, E., Dedryver, C.-A., Chaubet, B., Hullé, M. (2011). Les pucerons des plantes maraîchères. Cycles biologiques et activités de vol. ACTA –*INRA Ed.*, pp. 136.