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Potato Aphids and Their Natural Enemies in Tizi-Ouzou Northern of Algeria: Biodiversity and Importance

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Abstract:
Survey of potato aphids and their natural enemies in Tizi Ouzou Northern of Algeria during a year 2013, a total of 308 individual natural enemies comprised of 07 predatory species and 3 parasitoid species were collected and identified. The results showed the mean abundance of predators, especially ladybird's species and *Adonia variegata* (Goeze, 1777) is represented by 53.8%. Only some bugs were found and the aphid parasitoids were represented by three species *Aphidius ervi* (Haliday, 1833), *Diaeretiella rapae* (M'Intosh, 1855) and *Praon volucre* (Haliday, 1833).

Keywords: Diversity, Abundance, Potatoes, Predatory and Parasitoids.

INTRODUCTION

In 2014, Algeria occupied the fifteenth rang in producing potatoes in the world and the second one in Africa with a production of 4 673 516 Ton (FAO, 2016). In the Algerian territory, potatoes can be planted at any region. This plant is threatened by many diseases, pests and aphids (Hemiptera, Aphididae) are the most important insects harmful. They are very diverse; approximately 450 species are identified as pests of cultivated plants (Blackman and Eastop, 2000). Aphids cause great damages on the potatoes by sucking the sap. They weaken the plant; discolor the leaves and transmissing phytopathogenic viruses (Blackman and Eastop, 2000; 2006). In Algeria, the control of aphids is based essentially on using insecticide. Aphids can be controlled by a large scale of natural enemies (Lu et al., 2012), as predators, parasitoids and pathogens. Furthermore, both the larvae and the adult stages of ladybird species are predaceous on aphids, while only the larval stages of hoverflies and lacewings are predaceous on them. Among parasitoids, especially members of the subfamily Aphidiinae species belonging to the family Braconidae, are solitary endoparasitoids on aphid populations (Völkl et al., 2007). To develop a biological control strategy against aphids, it is important to study the biodiversity of natural enemies existing in the cultivated environment and in the adjacent one as well. In all habitats, natural enemy richness favored a more little knowledge about aphid natural enemies. The present study aims to investigate this fauna on potatoes in Tizi-Ouzou and study the dynamics of aphid enemy populations.

MATERIAL AND METHODS

Study area

This study was carried in a parcel of potatoes in Tizi-Ouzou region (36° 43′ 00″ N and 4° 03′ 00″ E) 200 m of altitude. This region is situated in the north of Algeria (Figure 1). Tizi-Ouzou is situated in the Mediterranean climate area, in the bioclimatic sub humid scale with a soft winter.

Figure 1: **A map of the region of Tizi-Ouzou and the localization of the study region.**
A: Map of Algeria showing the study region. B: the study region.

Applied methodology in the parcel

This study was made on potatoes planted on March 9th on a surface of 3000m². The study parcel was divided into nine blocks. In the middle of each block, a yellow trap had been placed. A plant in each block is chosen to recuperate the aphids and around a radius of 1m² of this plant, the auxiliaries of aphids had been recuperated by hand in order to evaluate their diversity and abundance. Every week, all the natural enemies falling in the yellow traps had been recuperated too. Water of yellow traps will be renewed at each time. Predators will be dispatched in the laboratory for identification.

Applied methodology in the laboratory

In the laboratory, the larvae of predators collected from aphid colonies are reared in boxes in the presence of aphids, in order to have the adults for identification. The nymphs and pupae are kept in breeding boxes until the adults come out to identify them. The mummified aphids were placed separately in petri dishes. After emergence, adults will be preserved in Ethanol.

Exploitation of the results

In this study, the ecological index of composition (the total richness and centesimal frequency) and the ecological indices of structures (Shannon-Weaver index and the equitability E) had been exploited.

Ecological composition indices

- **Total richness S**

Total richness S is equal to total number of present species. It is obtained from the total number of the picked up ones (Ramade, 1984).

- **Centesimal frequency**

The centesimal frequency is the percentage of individuals of a species (ni) by contribution to the total number of individuals (N) (Dajoz, 1971)

F (%) = ni × 100/N

ni: is the number of individuals of species taken into consideration.

N: is the number total of all individuals' confused species.

- **Ecological indices of structure**

The two ecologicals index of structure used in our study are the Shannon-Weaver index and the sign

of equitability **E**.

- **Shannon-Weaver diversity index**

According to Barbault (2008), this index is considered as the best medium of indicating the diversity. Shannon-Weaver diversity index is given by the following formulation (Ramade, 1984):

$$H' = - \sum qi \log_2 qi$$

H': Shannon-Weaver diversity index expressed by bits.

qi: is equal to **ni / N** which **ni** is the number of individuals of species i ; N : is the total number of individuals.

A community will be more diversified than the Shannon-Weaver diversity index **H'** will be big (Blondel, 1979).

- **Equidistribution or equitability index**

The equitability is the specific diversity report to the maximal diversity (Blondel, 1979), it is calculated by the following formulation:

$$E = H' / H' max$$

H': is the sign of the observed diversity

H' max: is expressed by bits.

$$H' max = \log_2 S$$

S: is the total richness

RESULTS

Three hundred eight individual of auxiliaries had been captured and recuperated, during the 12 weeks of observation (Tableau 1).

Exploitation of results by the ecological indices of composition

The total richness

A total richness of 10 natural enemies species of aphids was noted (Table 1). These species belong to 5 orders, 6 families and 7 subfamilies. Among them, 7 species are predatory and 3 species are parasitoids.

Table 1: List of natural enemies of aphids identified on potatoes

Species of aphidophagous collected			Number of individuals	Relative abundance (%)
Predators	Anthocoridae	*Anthocoris nemoralis* (Fabricius, 1794) (adult)	1	0.3 %
	Chrysopidae	*Chrysoperla carnea* (Stephens, 1836) (larva)	27	8.8 %
		Chrysoperla carnea (adult)	21	6.8 %
	Coccinellidae	*Adonia variegata* (Goeze, 1777) (larva)	32	10.4 %
		Adonia variegata (nymph)	17	5.5 %
		Adonia variegata (adult)	43	14 %
		Coccinella algerica (Kovar, 1977) (larva)	14	4.5 %
		Coccinella algerica (nymph)	12	3.9 %
		Coccinella algerica (adult)	36	11.7 %
		Scymnus pallipediformis (Gunther, 1958) (larva)	7	2.3 %
		Scymnus pallipediformis (adult)	10	3.2 %
	Miridae	*Malacocoris chlorizans* (Panzer, 1794) (larva)	1	0.3 %
		Malacocoris chlorizans (adult)	1	0.3 %
	Syrphidae	*Episyrphus balteatus* (De Geer, 1776) (larva)	31	10.1 %
		Episyrphus balteatus (adult)	52	16.9 %
Parasitoids	Aphidiidae	*Aphidius ervi* (Haliday, 1833)	1	0.3 %
		Diaeretiella rapae (M'Intosh, 1855)	1	0.3 %
		Praon volucre (Haliday, 1833)	1	0.3 %
Total			**308**	**100 %**

During the 12 weeks of sampling, 308 individuals of natural enemies of aphids had been collected on potatoes. In terms of abundance, the Coccinellidae, the Chrysopidae and the Syrphidae are the global represented families. The family of Coccinellidae is essentially represented by the species, *A. variegata* (53.8% of collected ladybirds), followed by *C. algerica* (36.3% of collected ladybirds), while the family of Syrphidae and the family of Chrysopidae are represented by one species for each, *E. balteatus* and *C. carnea* with a total of 83 individuals and 48 individuals respectively is 27% and 15.6% of collected auxiliary insects. While Aphidiidae, which are represented by 3 species with a unique individual for each is 0.9% of collected auxiliary insects. At the end, the Anthocoridae family and the Miridae family are represented by one species for each.

Centesimal frequency

The results of centesimal frequency are presented in Figure 2, this last one show that *A. variegata* is the most species observed in the parcel of study with 29.9%, followed by the hoverfly *E. balteatus* with 26.9%, the third position is reserved to *C. algerica*, but the species weakly observed are *A. ervi, D. rapae, P. volucre* and *A. nemoralis.*

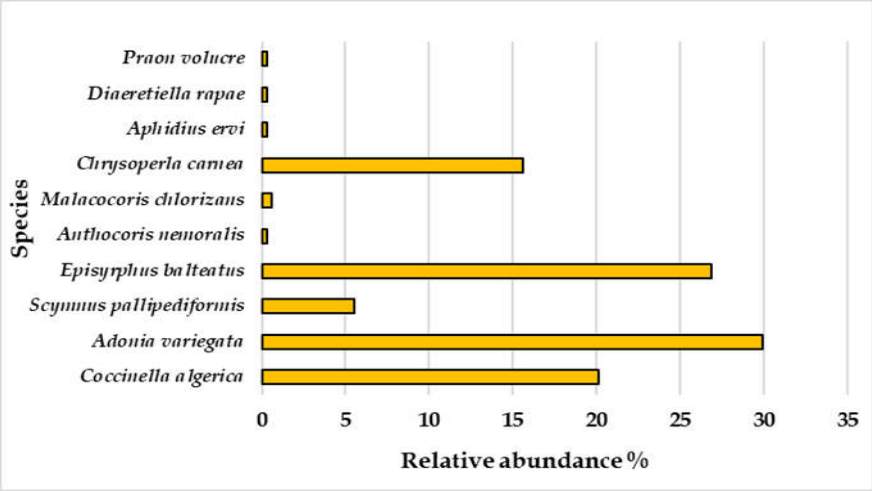

Figure 2: **Relative abundance of collected aphidophagous insects.**

Exploitation of results by the ecological indices of structure

The diversity index of Shannon-Weaver (H') calculated at the parcel (Figure 3) is of 0.69 Bits, the equitable is of 0.22, it tends towards 0, it indicates with a misbalance between the number of different grouped species. By contrary, the index of maximal diversity is equal to 3.01 Bits.

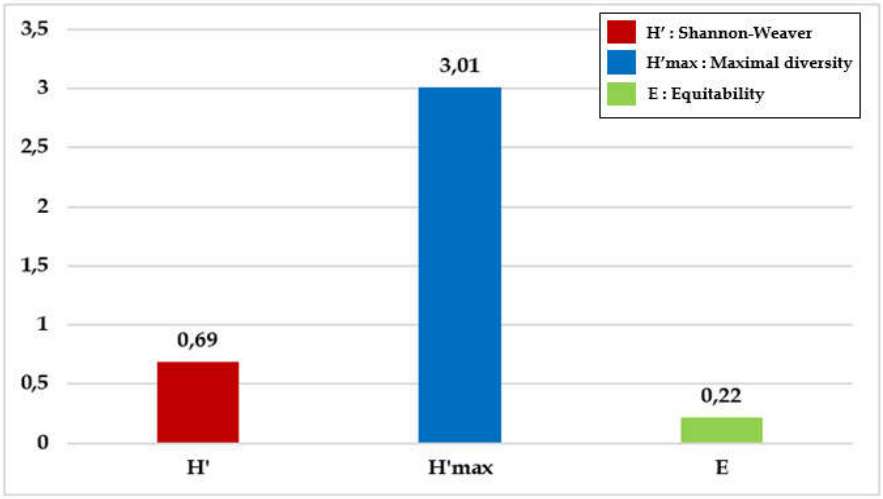

Figure 3: Shannon-Weaver diversity index, maximal diversity and the Equitability values.

Phenology of natural enemies by function of aphidian population

According to the results of the evolution profil of aphidian population and their natural enemies mentioned in Figure 4, show that the ladybirds are the first auxiliary that arrive in the study parcel.

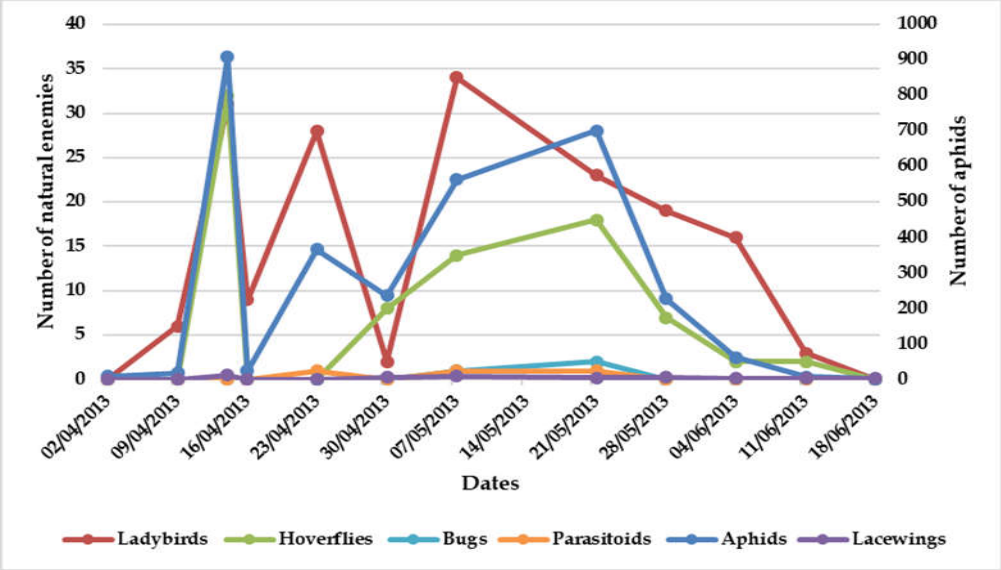

Figure 4: Phenology of aphid's population, of predators and of parasitoids aphidophagous collected on potatoes.

The number of these ladybirds increase progressively to reach a pick on April 23rd, 2013. A second pick is observed on May 7th, 2013 with 34 individuals of ladybirds is of 60% of the global population of auxiliaries. The hoverfly *E. balteatus* and the lacewing *C. carnea* arrive in second position, with a shift of 22 days. The activity of lacewings is the least important compared to the one of ladybirds and the hoverfly. It reaches a pick on May 14th, 2013 with 11 individuals is 16 % of the global population of predators. The activity of bugs and the parasitoids is very weak, they appear in the where they quite the edges and the enclosure.

DISCUSSION AND CONCLUSION

In the present study, 10 aphidophagous species had been identified. In 2018, in a similar study made on two crops: banana tree and tomato in Congo by Lofinda Lifake et al. (2018), 12 aphidophagous species had been identified and the predator represented by Ladybirds are the dominate aphidophagous. These results agree with the works of Francis et al. (2001), in Belgium in cultures of broad bean and those of Lopes et al. (2012) on vegetable crops in eastern China, which put in evidence the dominant character of Coccinellidae family.

The predominance of this family would explain itself by the presence of host plants serving as habitat for *C. algerica.* This is affirmed by Ben Halima-Kamel et al. (2011), in a study of habitat and prey of *C. algerica* in different coastal regions of Tunisia. These authors note that ladybird can shelter on 72 vegetal species, 09 of them are presented in the present parcel. On S*olanum tuberosum*, ladybird had been observed by Ben Halima-Kamel et al. (2011) with all the biological stages (eggs, larva, nymph and adult).

Hoverflies are grouped in the present work with 27% of the global population of auxiliaries. Our results corroborate with the effectuated study by Alhmedi et al. (2007) on the diversity evolution of aphids and their natural enemies in big crops approximately of Nettle parcels in Belgium. This study reveals the presence of hoverflies with 26, 8 %. While for lacewings, another study conducted in China by Lopes et al. (2012) shows that *C. carnea* is the only species of Chrysopidae family that develops on potatoes.

The carried out inventory of parasitoids show the existence of 3 species. They are: *A. ervi, D. rapae* and *P. volucre*. They are considered us generalist parasitoid species and they were reported in the Algerian East by Laamari et al. (2011) in a natural and cultivated environment and by Ben Halima-Kamel and Ben Hamouda (1993), in Tunisia on protected crops. According to Le Guigo (2010), *D. rapae* is able to addle more than 60 species of aphids in the world. In China, on potatoes and courgette, Lopes et al. (2012) focused on the presence of *D. rapae* on these two crops. Alhemdi et al. (2006), in Belgium on Nettle, note the presence of 4 species of parasitoid which *P. volucre*. Laamari et al. (2011), in their study on plants-aphids-parasitoid interactions in natural and cultivated environments in the East of Algeria, affirmed that *A. ervi* parasite 13 species of aphids which *Macrosiphum euphorbiae* and found that *D. rapae* parasite *Myzus persicae.*

The diversity index of Shannon-Weaver (H') calculated at the parcel of potatoes is weak. According to Francis et al. (2001), the diversity of insects is strongly influenced by the environment close of the crop field. Our results don't match with those of Saharaoui (2008) who found very high diversity of Shannon-Weaver index on ladybird populations and it varied of 4, 04 bits to 4, 35 bits in the North. Brodeur et al. (2013) affirmed that the success of an agent in biological control is based on its capacity to detect and exploit a pest and the study of the ecological density-dependency phenomena, including the functional and numerical responses of a predator to the abundance of its prey, and the synchronization of activities between pests and their natural enemies.

The activity of ladybirds is important during the two first months. Saharaoui and Gourreau (1998) affirm that during the spring, these two ladybirds cohabit together on herbaceous plants particularly on *Solanum tuberosum*. Registered picks coincide with the aphid's demographic explosion. Saharaoui and Gourreau (2000) affirm that *C. algerica* has an intense activity during the months of April and May. *E. balteatus* and *C. carnea* arrive late. Lateness of the species is probably attached to climate condition such as temperature and air humidity. Legemble (2008) signals that the presence of *E. balteatus* is guaranteed by raised temperatures associated to a hygrometric degree, they assure development and quick emergence of eggs. The activity of lacewings is less important compared to the one of ladybirds and of hoverflies. According to Mignon et al. (2003), in the agrosystems, the presence and the persistence of lacewings depend on the avaibility of prey and the vegetal composition variability of crop adjacent habitats.

In conclusion, on the base of data of this first investigation concerning natural enemies of aphids on potatoes in Northern Algeria, we established a first list of aphidophagous in Tizi-Ouzou region.

Therefore, the elaboration of an efficient strategy for a biological control against potato aphids, it will be very necessary to require the accumulation of the maximum knowledge regarding alternative hosts of aphidophagous of potato aphids in all Algerian territory.

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