Aphid (Hemiptera: Aphidoidea) diversity in Tunisia in relation to seed potato production

Sonia Boukhris-Bouhachem [1], Rebha Souissi [1], Evelyne Turpeau [2], Joëlle Rouzé-Jouan [2], Mohamed Fahem [3], Nadia Ben Brahim [4] & Maurice Hullé [2,*]

[1] INRAT, Laboratoire de Protection des Végétaux, Rue Hédi Karray, 2049 Ariana, Tunis, Tunisie

[2] INRA, UMR BiO3P, BP 35327, F-35653 Le Rheu Cedex. France

[3] GIL, Rue Maouia Ibn Abou Sofiène. Le Belvédère, B.P. 178, 1002 Tunis, Tunisie

[4] INRAT, Laboratoire de Botanique Végétaux, Rue Hédi Karray, 2049 Ariana, Tunis, Tunisie

* Corresponding author

Abstract. Winged morphs of aphids were investigated from 2002 to 2004 in 4 Tunisian regions of potato seeds production in order to know the aphid diversity and the potential vectors of Potato Virus Y. This is a very important contribution to the knowledge of aphid fauna in Maghreb. A total of 50,030 aphids were caught using yellow water traps and one suction trap. 130 taxa were identified including 103 species. Ten species are well represented in all regions prospected and typical species were also observed in every region. Some differences in species diversity appeared between regions which are discussed considering weather condition and vegetation.

Résumé. **La diversité d'Aphides (Hemiptera : Aphidoidea) en Tunisie en relation avec la production de plants de pomme de terre.** Afin de connaître les pucerons ailés potentiellement vecteurs de maladies de la pomme de terre (virus Y de la pomme de terre), des pièges ont été installés de 2002 à 2004, dans 4 régions de production de plants de pomme de terre en Tunisie. Cette étude est une importante contribution à la connaissance de la faune aphidienne dans le Maghreb. A partir des pièges jaunes et d'un piège à succion nous avons pu capturer 50.030 pucerons composés de 130 taxons dont 103 espèces ont été déterminées. Dix espèces sont abondantes dans toutes les régions, des différences entre les 4 régions ont cependant été révélées. Celles-ci sont discutées en relation avec les conditions de température et de végétation.

Keywords: Taxonomy, biodiversity, environment, Suction trap, Yellow water trap.

Tunisian invertebrate fauna is poorly known with few insects and very few nematodes identified in relation with agricultural impact. In the literature, a list of sixty pest species was made out among Arachnida, Collembola, Orthoptera, Dictyoptera, Thysanoptera, Hemiptera, Heteroptera, Psocoptera, Coleoptera, Hymenoptera, Diptera, Lepidoptera and Nevroptera (Zouaghi *et al*. 1999; Jerraya 2003). Some preliminary studies made inventory of aphid species in Tunisia; Chérif & Boudhir (1990) cited 5 species, Boukhris *et al.* (1996) reported 14 species and Ben Halima-Kamel & Ben Hamouda (2004) mentioned 20 aphid species. The same is known for other countries around the Mediterranean area: in Egypt, 8 (Harakly & Assem 1978) and 99 species (Al-Nagar & Nieto Nafria 1998) species; 17 species in Morocco (Starý & Sekkat 1987); 24 and 73 species in Libya and Algeria respectively (Al-Nagar & Nieto Nafria 1998). These lists are very incomplete compared to about 4700 aphid species in the World (Moran 1992; Radcliffe & Ragsdale 2002) and despite the fact that there are fewer species towards tropical and equatorial regions (Grassé 1951; Dixon *et al.* 1987),

Aphids are injurious pests in potato crops mainly because of their migrating behaviour favouring their capacity of transmission viruses including the Potato Virus Y (PVY) which is the most economically important virus in Tunisian fields (Chérif & Boudhir 1990; Jendoubi 2001), In the case of that non-persistently transmitted virus, more than 50 aphid species were cited to be vectors (Varveri 2000; Robert & Bourdin 2001), Many of these species don't reproduce on potatoes, PVY is transmitted by winged aphid just visiting and probing plants. The knowledge of aphid species present in the vicinity of crops and their abundance when crops are sensitive is a preliminary and indispensable step for any study of the epidemiology of PVY disease.

E-mail: maurice.hulle@rennes.inra.fr, bouhachem.sonia@iresa.agrinet.tn

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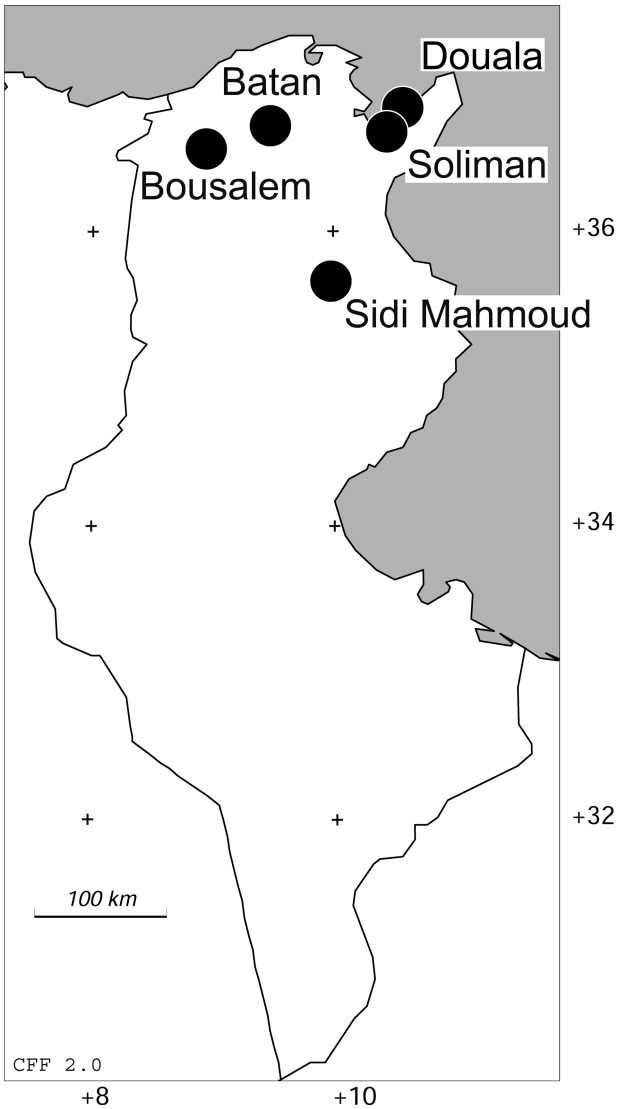

Figure1
Distribution of yellow water traps and suction trap in Tunisia.

This paper aims to establish aphid species composition in several regions of Tunisia previously to a further study of the potential risks of virus transmission by aphids in seed production sites.

Materials and Methods

Prospected regions

Four regions of Tunisia were chosen for this study (fig. 1, tab. 1): **in the North**, Cap bon (sites of **Douala** 36°50'34"N 10°36'44"E and **Soliman** 36°40'40"N 10°28'20"E) a costal zone located in sub-humid area, with Kermes oaks (*Quercus* cf. *coccifera* L.) forest, *Cystus* sp. and varied crops (vegetables, fruit trees, various *Solanum* species – potato, tomato, pepper-) and hedges; Manouba (site of **Batan** 36°43'09"N 9°29'10"E) a semi-arid area with warm winter zone characterised by Oleolentisc forest with mixed farming; Jendouba (site of **Bousalem** 36°33'42"N 8°56'40"E) a continental zone and sub-humid area with Oleolentisc forest and cereal cultures, sugar beet and vegetables; **in the Center**, Kairouan (site of **Sidi Mahmoud** 35°39'50"N 9°59'10"E), a continental zone with arid cold winter and steppe with *Artemisia campestris* L. halophytes and developing horticultural region with vegetables, fruit trees, *Solanum* species; Sidi Mahmoud is a new site for producing Spunta and Nicola potato seeds.

Climate data

The climate data have been provided by the Bioclimatology Laboratory of I.N.R.G.R.E.F. and by National Institute of Meteorology (tab. 1).

Sampling methods

The aphid inventory was realised by trapping winged form of aphids. During 3 years, from 2002 to 2004, aphids were collected in the four regions with yellow water traps (Moericke 1955). Two traps were placed in each region, one in the middle of the seed potato field during the season at 0.7m above the soil level, from the time of potato plant emergence until haulm destruction (*i.e.* from beginning of February to late May), and the second one in G.I.L. stations (Groupement Inter-professionnel des Légumes) during the whole year (except in Douala where this second trap was placed on the edge of seed potato field). In addition, a suction trap was operated in Soliman from July 2002 until now. This trap catches flying insects at 12m above the soil level.

Table 1. Main meteorological characteristics of sampling sites.

Regions	Cap Bon	Manouba	Jendouba	Kairouan
Sampling sites	Douala, Soliman	Batan	Bousalem	Sidi Mahmoud
Mean annual temperature	18.7 °C	19.6 °C	19.1 °C	19.7 °C
Mean min temperature	13.7 °C	14.5 °C	12.2 °C	13.3 °C
Mean max temperature	23.7 °C	24.7 °C	26.0 °C	26.1 °C
Annual rainfall (mm)	455	381	429	311
Number of days with rainfall per year	59	74	68	64

Aphids were collected twice a week for water traps and every day for suction trap. Specimens were preserved in 96% ethanol until identification. Species were identified with several keys: Remaudière & Seco Fernandez (1990), Blackman & Eastop (2000), Jacky & Bouchery (1984), but sometimes only the genera could be identified.

Results

A total of 50,030 aphids were caught during this survey. 103 species were identified among 130 taxa (table 2). Except one *Phylloxeridae*, all species belong to the *Aphididae*. 8 subfamilies, *Anoeciinae*, *Aphidinae*, *Calaphidinae*, *Chaitophorinae*, *Eriosomatinae*, *Lachninae*, *Phyllaphidinae* and *Thelaxinae* (Remaudière & Remaudière 1997) were found within this family. In the four regions, more than 70% of the species belong to the *Aphidinae*.

Variability due to trapping

In the region of Cap Bon, both types of traps have been operated; more aphids and more taxa were caught in the suction trap than in the water traps. 11 genera (corresponding to 23 species) were caught only in Soliman suction trap and not in water pan traps. These genera were *Amphorophora*, *Clypeoaphis*, *Hysteroneura*, *Nasonovia*, *Chromaphis*, *Chaitophorus*, *Periphyllus*, *Aloephagus*, *Eriosoma*, *Geoica* and *Thecabius*. Conversely, 3 genera, *Hayhurstia*, *Microlophium* and *Staegeriella*, have been caught in Douala water pan traps and not in suction trap.

Species frequencies were also different between traps. The 3 more abundant species in water traps were potato aphids i.e. *Myzus persicae* (11.28%), *Aphis gossypii* (9.19%) and *Aphis fabae* (5.04%). In suction trap, *A. gossypii* (20.46%) and *M. persicae* (8.08%), were abundant but also non potato aphid such as *Aploneura lentisci* (10.38%), which alternates between Pistachio tree, *Pistacia lentiscus* and Graminae. *Hyalopterus pruni* (7.71%) which alternates between almond trees, peach and *Phragmites* (Jerraya 1997) or *Rhopalosiphum padi* (7.54%), which alternates between *Prunus padus* and Graminae.

Variability due to regions

Douala exhibited the highest number of taxa, species and genera and Bousalem the lowest. Among the known vectors of PVY, the main differences were observed for *A. gossypii* which represented more than 50% of catches at Sidi Mahmoud and only 9.19% at Douala, *Aphis spiraecola* which was much more abundant in Batan (18.92%) and Bousalem (19.91%) than at the 2 other sites. *Lipaphis erysimi* was very abundant in Bousalem (14.87%), *M. persicae* with 11.28% at Douala and less than 5% at Sidi Mahmoud and *Schizaphis graminum* more abundant at Douala (3.27%).

The total amount of known vectors was much higher in Bousalem and Sidi Mahmoud with respectively 77.65% and 77.88% of catches than in Batan (59.15%) and Douala (51.59%). Taking into account the total number of aphids, the risk of virus transmission was the highest at Sidi Mahmoud, mainly because of a very high density of *A. gossypii*.

It is worth noting that within the *Aphis* genera, many aphids were not identified at the species level in Batan and Douala, and this could modify the previous results.

The number of taxa in each region was correlated to the mean max temperature observed during the survey. The highest was the temperature, the lowest was the number of taxa which is the case of Sidi Mahmoud and Bousalem (fig. 2).

Discussion

Faunistics

With 130 taxa including 103 species, this survey constitutes the most important contribution to the knowledge of aphid diversity in Tunisia. This richness as well as the decreasing number of species towards the south is in accordance with models which predict a lessening number of aphid species from temperate countries to the tropics because of constraints imposed by their way of life, namely their host specificity and the low probability to find suitable host plants (Dixon *et al.* 1987). Following these authors, with 2200 vascular plants (Ben Brahim *et al.* 1995) and 103 species, ratio of the number of aphid to plant species observed in Tunisia is similar to those observed in other Mediterranean countries such as Turkey or Spain.

This survey pointed out that Tunisian aphidofauna

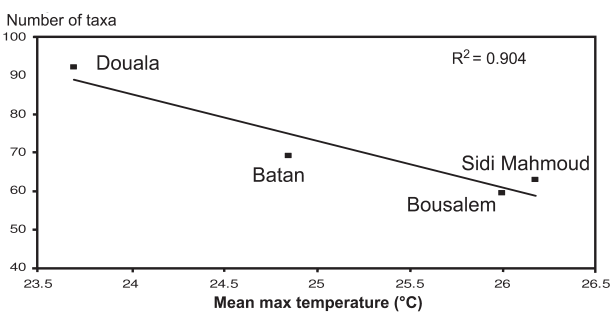

Figure 2
Relation between number of aphid taxa in water traps and the mean max temperature for the four sampling areas.

Table 2. Aphids collected in Tunisia from 2002 to 2004 in five locations.
YWT: yellow water traps, ST: suction trap. * aphids reported to transmit Potato Virus Y (DiFonzo et al. 1997; Edwardson & Christie 1997; de Bokx 1987; Peters 1987; Piron 1986)). Values are % of the total amount for each location.

	Locations	Batan	Bousalem	Sidi Mahmoud	Douala	Soliman	Grand total
	Trap model	**YWT**	**YWT**	**YWT**	**YWT**	**ST**	
	Total number of specimens	**6973**	**4756**	**7428**	**6365**	**24508**	**50030**
	Total number of species	**58**	**47**	**53**	**78**	**83**	**103**
	Total number of genera	**44**	**41**	**42**	**48**	**58**	**59**
	Species	%	%	%	%	%	%
	Acyrthosiphon gossypii Mordvilko	0.01	0.08	0.05	0.31	-	0.06
*	*Acyrthosiphon malvae* (Mosley)	0.07	-	-	1.57	0.05	0.23
*	*Acyrthosiphon pisum* (Harris)	5.41	5.57	5.68	4.48	1.89	3.62
	Aloephagus myersi Essig	-	-	-	-	0.03	0.01
	*Amphorophora rubi (*Kaltenbach)	-	-	-	-	<0.01	<0.01
	Anoecia corni (Fabricius)	0.03		0.12	0.05	0.03	0.04
	Anoecia spp.	0.04	0.04	0.12	0.03	0.02	0.04
	Anoecia vagans (Koch)	-	-	-	-	0.01	<0.01
	Anuraphis farfarae (Koch)	-	-	0.01	-	<0.01	<0.01
	Anuraphis subterranea (Walker)	-	-	-	0.17	<0.01	0.03
*	*Aphis craccivora* Koch	0.57	0.46	0.36	1.81	2.76	1.76
*	*Aphis fabae* Scopoli	2.22	3.62	1.79	5.04	3.41	3.23
*	*Aphis gossypii* Glover	18.47	19.91	55.30	9.19	21.46	24.36
	Aphis nerii Boyer de Fonscolombe	1.76	0.23	0.16	0.41	1.81	1.23
*	*Aphis pomi* De Geer	-	-	-	2.00	0.07	0.29
	Aphis spp.	14.93	5.47	3.22	20.02	2.97	7.08
*	*Aphis spiraecola* Patch	18.92	23.91	2.36	4.82	2.99	7.34
	Aphis verbasci Schrank	0.01	-	-	0.63	0.18	0.17
	Aploneura lentisci (Passerini)	4.42	1.37	2.23	4.68	10.38	6.76
*	*Aulacorthum solani (*Kaltenbach)	0.20	0.04	0.04	0.17	0.22	0.17
	Baizongia pistaciae (L.)	-	-	-	0.02	0.18	0.09
	Brachycaudus amygdalinus (Schouteden)	-	-	-	0.06	0.01	0.01
	Brachycaudus cardui (L.)	1.09	0.61	0.09	3.16	0.91	1.07
*	*Brachycaudus helichrysi* (Kaltenbach)	0.69	0.59	0.32	0.71	0.19	0.38
	Brachycaudus persicae (Passerini)	-	0.29	0.05	0.11	-	0.05
	Brachycaudus rumexicolens (Patch)	0.14	0.15	2.36	0.22	0.04	0.43
	Brachycaudus schwartzi (Börner)	-	0.06	0.03	0.03	0.43	0.22
	Brachycaudus spp.	0.03	0.27	0.07	-	-	0.04
	Brachycorynella asparagi (Mordvilko)	0.11	0.06	0.12	0.02	<0.01	0.05
	Brachyunguis harmalae B. Das	-	-	-	0.09	-	0.01
	Brachyunguis sp.	0.13	1.05	1.90	0.77	0.11	0.55
	Brachyunguis tamaricis (Lichtenstein)	-	-	-	0.03	0.01	0.01
	Brevicoryne brassicae (L.)	0.01	-	-	0.46	0.03	0.07
*	*Capitophorus elaeagni* (del Guercio)	1.13	0.21	0.42	0.36	1.33	0.94
*	*Capitophorus hippophaes* (Walker)	0.06	-	-	0.03	0.34	0.18
	Capitophorus horni Börner	-	-	0.01	-	-	<0.01
	Capitophorus spp.	0.03	-	-	0.06	0.01	0.02
*	*Cavariella aegopodii* (Scopoli)	0.01	0.04	0.03	0.80	0.20	0.21
	Cavariella archangelicae (Scopoli)	-	-	-	0.02	-	<0.01
*	*Cavariella pastinacae* (L.)	-	-	-	0.27	0.01	0.04
	Cavariella theobald. (Gillette & Bragg)	-	-	-	0.02	-	<0.01
	Chaitophorus leucomelas Koch	0.01	0.29	-	-	0.01	0.03
	Chaitophorus spp.	-	0.02	-	-	0.06	0.03
	Chromaphis juglandicola (Kaltenbach)	-	-	-	-	0.62	0.30
	Cinara costata (Zetterstedt)	-	-	-	-	0.11	0.05

Table 2. Continued.

	Locations	Batan	Bousalem	Sidi Mahmoud	Douala	Soliman	Grand total
	Trap model	**YWT**	**YWT**	**YWT**	**YWT**	**ST**	
	Total number of specimens	**6973**	**4756**	**7428**	**6365**	**24508**	**50030**
	Total number of species	**58**	**47**	**53**	**78**	**83**	**103**
	Total number of genera	**44**	**41**	**42**	**48**	**58**	**59**
	Species	%	%	%	%	%	%
	Cinara cupressi (Buckton)	-	-	-	0.02	0.01	0.01
	Cinara sp.	0.01	-	-	0.03	-	0.01
	Clypeoaphis suaedae (Mimeur)	-	-	-	-	0.02	0.01
	Coloradoa tanacetina (Walker)	-	-	0.01	-	-	<0.01
	Ctenocallis setosus (Kaltenbach)	0.11	0.27	0.01	0.08	0.01	0.06
	Diuraphis noxia (Kurdjumov)	0.01	0.13	0.32	0.22	0.01	0.09
	Dysaphis plantaginea (Passerini)	0.65	0.84	0.20	0.03	0.05	0.23
	Dysaphis pyri (Boyer de Fonscolombe)	-	-	-	0.20	0.04	0.05
	Dysaphis spp.	0.19	1.09	0.23	0.44	0.11	0.27
	Elatobium abietinum (Walker)	0.04	-	-	-	-	<0.01
	Eriosoma lanigerum (Hausmann)	-	-	-	-	<0.01	<0.01
	Essigella sp.	-	0.02	-	-	-	<0.01
	Eulachnus rileyi (Williams)	0.13	-	-	0.25	0.01	0.05
	Eulachnus sp.	-	-	-	0.24	<0.01	0.04
	Forda marginata Koch	0.24	0.08	0.07	0.03	0.11	0.11
	Geoica utricularia (Passerini)	0.50	-	0.04	-	0.80	0.47
	Hayhurstia atriplicis (L.)	0.10	0.02	0.07	0.97	-	0.15
	Hyadaphis coriandri (B. Das)	0.07	0.15	0.38	0.28	0.08	0.16
*	*Hyadaphis foeniculi* (Passerini)	0.07	0.06	0.03	0.36	0.04	0.09
	Hyalopterus amygdali (E. Blanchard)	-	-	-	0.19	0.07	0.06
*	*Hyalopterus pruni* (Geoffroy)	1.16	0.61	1.39	0.53	7.71	4.27
*	*Hyperomyzus lactucae* (L.)	2.38	4.04	2.21	1.89	0.97	1.76
	Hyperomyzus picridis (Börner & Blunck)	-	-	-	0.06	-	0.01
	Hysteroneura setariae (Thomas)	-	-	-	-	<0.01	<0.01
	Hysteroneura sp.	-	-	0.05	-	0.02	0.02
	Illinoia goldamaryae (Knowlton)	0.01	-	-	-	-	<0.01
	Illinoia sp.	-	-	-	0.50	0.07	0.10
*	*Lipaphis erysimi* (Kaltenbach)	1.05	14.87	5.88	2.33	0.82	3.13
*	*Macrosiphoniella sanborni* (Gillette)	-	-	-	0.14	0.23	0.13
	Macrosiphoniella spp.	-	-	-	-	0.02	0.01
	Macrosiphoniella tapuskae (Hottes & Frison)	0.04	0.04	0.01	0.08	0.03	0.04
*	*Macrosiphum euphorbiae* (Thomas)	0.14	0.44	0.28	1.96	0.97	0.83
	Macrosiphum rosae (L.)	1.53	0.95	0.74	0.27	0.15	0.52
	Macrosiphum sp.	-	-	-	-	0.02	0.01
	Melanaphis pyraria (Passerini)	-	0.25	-	0.06	0.01	0.04
	Melanaphis spp.	-	0.46	0.04	-	-	0.05
*	*Metopolophium dirhodum* (Walker)	0.10	-	0.03	0.09	0.15	0.10
	Metopolophium festucae (Theobald)	-	-	-	0.02	-	<0.01
	Microlophium sp.	-	-	-	0.02	-	<0.01
	Myzocallis castanicola Baker	-	0.06	0.07	0.02	<0.01	0.02
	Myzus cerasi (Fabricius)	-	-	-	0.02	-	<0.01
	Myzus lythri (Schrank)	0.16	-	-	2.01	0.05	0.30
*	*Myzus persicae* (Sulzer)	8.55	5.34	4.81	11.28	8.08	7.81
	Nasonovia ribisnigri (Mosley)	-	-	-	-	0.01	<0.01
	Ovatus craetaegarius (Walker)	-	0.02	-	-	0.38	0.19
	Ovatus inulae (Walker)	-	-	-	0.03	-	<0.01
	Ovatus sp.	-	-	0.03	0.02	<0.01	0.01
	Pemphigus spp.	-	0.17	0.01	0.03	0.01	0.03

Table 2. Continued.

	Locations	Batan	Bousalem	Sidi Mahmoud	Douala	Soliman	Grand total
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	Total number of genera	**44**	**41**	**42**	**48**	**58**	**59**
	Species	%	%	%	%	%	%
	Periphyllus spp.	0.01	-	-	-	<0.01	<0.01
	Phorodon spp.	-	0.02	-	-	<0.01	<0.01
	Phyllaphis fagi (L.)	0.06	-	-	-	-	0.01
	Phylloxera ilicis Grassi	-	-	-	-	0.13	0.06
	Phylloxera sp.	0.01	-	-	0.22	0.08	0.07
	Rhodobium porosum (Sanderson)	0.06	0.02	0.03	0.09	<0.01	0.03
*	*Rhopalosiphum insertum* (Walker)	0.03	-	0.01	0.66	0.33	0.25
*	*Rhopalosiphum maidis* (Fitch)	0.80	1.72	1.23	0.94	3.00	2.05
	Rhopalosiphum nymphaeae (L.)	-	0.06	0.86	0.71	0.76	0.60
*	*Rhopalosiphum padi* (L.)	1.74	1.56	0.13	1.90	7.54	4.35
	Rhopalosiphum rufiabdominale (Sasaki)	0.01	-	-	0.02	-	<0.01
	Rhopalosiphum rufulum Richards	-	-	-	0.19	0.16	0.10
	Saltusaphis scirpus Theobald	0.01	-	0.07	0.93	1.07	0.65
*	*Schizaphis graminum* (Rondani)	0.57	0.71	0.58	3.27	3.46	2.34
	Schizaphis minuta (Van der Goot)	-	-	-	-	0.65	0.32
	Schizaphis rotundiventris (Signoret)	0.03	-	0.03	0.06	0.32	0.17
	Schizaphis sp.	-	-	-	0.02	0.10	0.05
	Semiaphis dauci (Fabricius)	0.10	0.04	0.08	0.06	0.07	0.07
	Sipha maydis Passerini	0.01	-	0.01	0.39	0.01	0.06
	Sitobion africanum (Hille Ris Lambers)	-	-	-	-	<0.01	<0.01
*	*Sitobion avenae* (Fabricius)	0.42	0.59	0.20	0.64	1.13	0.78
*	*Sitobion fragariae* (Walker)	0.04	-	0.03	0.11	0.29	0.17
	Smynthurodes betae Westwood	-	-	-	0.20	0.01	0.03
	Staegeriella necopinata (Börner)	0.01	0.13	0.03	0.05	-	0.02
	Stomaphis sp.	-	0.02	-	-	-	<0.01
	Tetraneura ulmi (L.)	5.42	0.27	0.01	0.25	0.73	1.17
	Thecabius lysimachiae Börner	-	-	-	-	<0.01	<0.01
	Thecabius sp.	-	-	-	-	0.49	0.24
	Thelaxes dryophila (Schrank)	0.01	-	-	0.03	0.03	0.02
	Thelaxes sp.	0.01	0.06	-	0.19	0.01	0.04
	Thelaxes suberi (Del Guercio)	-	0.02	0.01	0.2	0.04	0.05
	Therioaphis onodinis (Kaltenbach)	-	-	-	0.03	<0.01	<0.01
	Therioaphis trifolii (Monell)	0.43	0.15	2.02	0.24	0.09	0.45
	Toxoptera aurantii (Boyer de Fonscolombe)	0.04	0.02	-	0.19	0.01	0.04
	Uroleucon sonchi (L.)	0.11	0.23	0.16	-	0.22	0.17
	Uroleucon spp.	2.24	0.08	0.74	1.10	5.28	3.16

is diverse, composed of some African species, Mediterranean species, species of temperate or warm temperate countries and cosmopolitan species.

Actually, some species caught during this survey appeared to be specific of the African continent. This is the case of *Aloephagus myersi*, *Schizaphis rotundiventris*, *Schizaphis minuta*, *Sitobion africanum* (Blackman & Eastop 2000; Remaudière *et al,* 1985), Species such as *Acyrthosiphon gossypii*, *Aphis verbasci*, *Brachyunguis harmalae, B. tamaricis*, *Hyadaphis coriandri* and *Sipha maydis* are mainly Mediterranean, Other species have been recently introduced in Africa: *Hysteroneura setariae* in 1967 (Blackman & Eastop 2000), *Cinara cupressi* in 1986 (Mills 1990) for instance. Finally, *Toxoptera aurantii* is distributed throughout the tropics and subtropics or in glasshouses in temperate climate. It is a polyphagous species, and a major pest on *Citrus*.

The other species have a wider geographical distribution. From all species listed, 10 aphids were cited before in both Tunisia and Morocco: *A. gossypii, A. fabae, A. craccivora, Acyrthosiphon pisum, Myzus persicae, Macrosiphum euphorbiae, Eriosoma lanigerum, Hyalopterus amygdali, R. maidis, S. graminum* (Kassebeer *et al.* 1976). Further other species were cited by Starý & Sekkat (1987) in Morocco as *H. pruni, Metopolophium dirhodum, Uroleucon sonchi, Brevicoryne brassicae, Brachycaudus amygdalinus, Macrosiphum rosae, Chromaphis juglandicola, Aphis punicae* and *A. affinis*. *Geoica utricularia* was also already known from Morocco (Blackman & Eastop 2000).

Main biological characteristics of aphid species

The most abundant species of this survey are cosmopolitan. Almost all are polyphagous, with some of them commonly breeding on potatoes (*A. gossypii*, *A. fabae*, *M. persicae*).

A. gossypii was predominant during this survey and particularly in Sidi Mahmoud where the temperatures are hot compared to the other regions. In fact *A. gossypii* is known to prefer glasshouses and hot conditions in temperate regions. This species is extremely polyphagous. It is widely distributed in the Mediterranean region, in France, Italy, Spain, Egypt, Palestine, and Morocco (Balachowsky & Mesnil 1936). It is interesting to note that this species may transmit more than 50 plant viruses (Blackman & Eastop 2000).

M. persicae was less numerous but very well distributed in the 4 regions. The frequencies were similar to those obtained in a previous study (Chérif & Mnari Hattab 1994). This species is known to be very polyphagous having more than 875 secondary hosts (Blackman & Eastop 1984). This species is also a principal virus vector that transmits more than 100 viruses (Kennedy *et al.* 1962) and the most efficient vector of PVY (Radcliffe & Ragsdale 2002).

A. fabae was also present in all the regions studied. It is very polyphagous on its secondary host plants. It is particularly important for its direct feeding damage to *Vicia faba* and as virus vector on plants. It is a vector of more than 30 plant pathogenic viruses, including non-persistent viruses of beans, potato, tobacco, tomato and the persistent beet yellow viruses and potato leaf roll (Blackman & Eastop 2000).

Some other abundant species of this survey are known to be vectors of non persistent viruses including PVY. *A. spiraecola* was also abundant probably because of the presence of *Citrus* in the surroundings of all sampling sites. It is a polyphagous aphid with numerous host plants in over 20 families, but especially on Caprifoliaceae, Compositae, Rosaceae, Rubiaceae and Rutaceae, all present in Tunisia. It is a vector of Citrus Trizteza Virus. Cucumber Mosaic, Plum Pox, Potato viruses and others. It has been in North America at least since 1907 and was introduced more recently to the Mediterranean region in about 1939 and in Africa since 1961 (Blackman & Eastop 2000). It has been identified in Tunisia by Boukhris *et al.* in 1996 and Ben Halima *et al.* in 2004. *A. pisum* living mostly on Leguminosae is known as a vector of more than 30 virus diseases including non-persistent viruses of beans, peas, and of others. *Hyperomyzus lactucae* reported in the Mediterranean region breeds on *Ribes* species as primary host and *Sonchus oleraceus* as secondary hosts which are widespread in Tunisia. It is a vector of about 12 non-persistent viruses. *R. padi* is able to transmit the persistent viruses barley yellow dwarf (Blackman & Eastop 2000) as well as non-persistent virus like PVY on potato. *Lipaphis erysimi* worldwide distributed is observed on Cruciferous and is a vector of about 10 non-persistent plant viruses. All these species being potential vectors of PVY, their efficiencies of transmission have therefore to be checked in the conditions of Tunisia to confirm their role in the infection of potato fields.

Aploneura lentisci which alternates between *Pistacia lentiscus* and Graminae was very abundant in this survey; it is not yet known to transmit PVY. This also has to be checked in the conditions of Tunisian potatoes production.

Comparison of potential aphid vectors in the four regions

Virus transmission rate is dependent on many factors such as the abundance and the phenology of vectors, the efficiency of transmission, and the environmental factors (virus sources at the beginning and during of the season. host-plants…). During this study, only the species abundance was surveyed. Each of the 4 regions present their own epidemiological characteristics but they all harbour PVY vectors in abundance. Vectors catches accounted for between 60 and 80% of the total amount of aphids. From this only faunistic aspect, all regions seem similar except Jendouba which has the lowest number of aphids. A new production area such as Kairouan does not appear safer than traditional ones like Cap Bon or Jendouba. But this apparently high potential risk has to be adjusted with regards to all above mentioned factors. This study has to be considered only as a first step of a more complete epidemiological study.

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