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Influence of surrounding trees on the populations of phytoseiid mites (Acari Phytoseiidae) in a vineyard of the Lazio region (Central Italy)

Abstract - Research was carried out in a hilly area of the Lazio region, close to the border of the Abruzzo and Lazio National Park, in the province of Frosinone (Central Italy). Two highly profitable crops were investigated namely, vine and olive, together with surrounding wild and cultivated trees. The aim of this research was to study the phytoseiid mites community associated to different plant species in the experimental area and to evaluate the fluctuation of the population density of these mites, in order to investigate the influence of border plants on the presence and spread of these predators in the cultivations. The crops were mainly olive and vine whereas the surrounding areas were made up of woodland, with a strong dominance of *Quercus* spp. Agronomic techniques were also taken into consideration, particularly the pest and disease control strategies and the pesticides used. The samplings of phytoseiids were carried out from the beginning of 2001 till the end of 2002, every 14 days, on 9 different sampling points made up of the following plant species: oak, maple, elm, vine, olive, cherry-tree, apple, hazelnut and fig. Fifteen different species of phytoseiids were collected, in the following order of importance: *Kampimodromus aberrans*, *Euseius finlandicus*, *Kampimodromus langei*, *Typhlodromus aceri*, *Amblydromella crypta*, *Amblydromella athenas*, *Typhlodromus baccettii*, *Typhlodromus intercalaris*, *Bawus talbii*, *Typhloseiulus simplex*, *Typhlodromus pyri*, *Seiulus eleonorae*, *Seiulus soleiger*, *Seiulus amaliae* and *Typhlodromus recki*. Among all these species *K. aberrans* proved to be present and widespread on all the investigated plants. Moreover it has been confirmed that *Quercus pubescens* Willd. is an important reserve of phytoseiids and its presence strongly influences the widespread of these arthropods on the nearby plants.

Riassunto - *Influenza delle piante di bordo sulle popolazioni di acari fitoseidi (Acari Phytoseiidae) in un vigneto del Lazio (Italia centrale).*

La ricerca è stata condotta nel corso degli anni 2001- 2002, in un'area collinare della regione Lazio, confinante con il Parco Nazionale di Lazio e Abruzzo, in provincia di Frosinone (Centro Italia). Sono state prese in esame due colture di alto reddito, vite e olivo e le piante arboree adiacenti, spontanee e coltivate. Scopo della ricerca è lo studio degli acari fitoseidi associati alle differenti specie vegetali del campo sperimentale e la fluttuazione della loro popolazione, al fine di conoscere l'influenza delle piante di bordo sulla presenza e la diffusione di questi utili predatori nelle coltivazioni. Le colture sono olivo e soprattutto vite, mentre le zone circostanti includono boschi misti con dominanza del genere *Quercus*. Sono state inoltre prese in esame le pratiche agronomiche, in particolare i protocolli di difesa fitosanitaria. I campionamenti dei fitoseidi sono stati effettuati a partire dal mese di gennaio 2001 fino alla fine dell'anno 2002, con cadenze di 14 giorni, su 9 differenti stazioni di prelievo, costituite dalle seguenti essenze vegetali: quercia, acero, olmo, vite, olivo, ciliegio, melo, nocciòlo e fico. Sono state raccolte quindici specie di fitoseidi, che, in ordine di importanza, sono: *Kampimodromus aberrans*, *Euseius finlandicus*, *Kampimodromus langei*, *Typhlodromus aceri*, *Amblydromella crypta*, *Amblydromella athenas*, *Typhlodromus baccettii*, *Typhlodromus intercalaris*, *Bawus talbii*, *Typhloseiulus simplex*, *Typhlodromus pyri*, *Seiulus eleonorae*, *Seiulus soleiger*, *Seiulus amaliae* e *Typhlodromus recki*. Tra le diverse specie *K. aberrans* è stato rinvenuto con larga diffusione su tutte le piante campionate. Inoltre la roverella (*Quercus pubescens* Willd.) ha confermato il suo utile ruolo di riserva per le popolazioni dei fitoseidi e l'influenza sulla loro diffusione tra le piante limitrofe.

Key words: Phytoseiidae, vineyard, surrounding plants, similarity.

INTRODUCTION

Modern agricultural techniques tend to eliminate hedgerows, wild plants, and weeds from the fields, and during grass-growing management very few species of grass are chosen. These choices are made in order to contain the production costs and to obtain the highest harvest but, unfortunately, the biological diversity is progressively reduced. Moreover the monoculture impoverishes the animal and plant species of the agroecosystem and more often than not they are eradicated from the cultivations. The consequences can be very serious when useful arthropods are eradicated as a side effect of some agronomic techniques.

The aim of this research is the investigation of the populations of phytoseiid mites and their relationship with the host plants, as well as expanding and dwelving further into the matter. This notwithstanding the fact that existing literature provides useful information in this field (Arutunjan, 1969; McMurtry *et al.,* 1971; Ragusa & Paoletti, 1985; De Lillo, 1987; Tuovinen & Rokx, 1991; Coiutti, 1993; Duso *et al.*, 1993; Tuovinen, 1993; Tuovinen, 1994; Duso & Fontana, 1996; Lozzia & Rigamonti, 1998; Tixier *et al.*, 1998; Castagnoli *et al.*, 1999; Nicòtina *et al.*, 2002).

Research work was carried out during 2001/2002 in a hilly area of the Lazio region (Central Italy) in the province of Frosinone. In order to investigate the relationship between the fluctuation of the population of phytoseiid mites on the cultivations and the presence and conservation of the surrounding wild plants. A complex agroecosystem was studied where agronomic management did not in any way restrict the spreading of phytoseiid mites. The plant species investigated were: olive, vine, different fruit trees and the wild trees surrounding them.

MATERIALS AND METHODS

Research was carried out in a field of about 6000 m^2 surrounded by different species of trees, especially oaks, but also elms and field maples.

The experimental field has an average altitude of 630 m above sea level, close to the Abruzzo and Lazio National Park; the soil is light, sub-acid, reddish and pebbly. The main cultivations are olive (about 500 m^2) and vine (about 2.300 m^2), while the oak woods are mainly found on the spontaneous areas (about 1.300 m^2).

The remaining part of the experimental field was full of a great variety of plants, including vines, oaks, fig, cherry and apple trees, a field maple, an olive and 13 hazelnut trees. Figure 1 shows the distribution of the different trees in the experimental field: for each kind of tree one sampling point was chosen, made up of 10 plants chosen at random.

The olive plants are irregularly scattered in the area, and do not present pathogenic problems.

The vineyard is twenty years old and is made up by 8 rows of about 30 plants each, trained on an espalier and a bower system. The cultivars are mainly Malvasia di Candia (more than 80%) and Montepulciano d'Abruzzo, both on SO4 rootstock. Powdery (*Oidium tuckeri* Berk.) and downy mildew (*Plasmopara viticola* Schw. & Burr.) management was carried out with five applications of Bordeaux mixture mixed with sulphur during the vegetative period in 2001 and in 2002; a further application

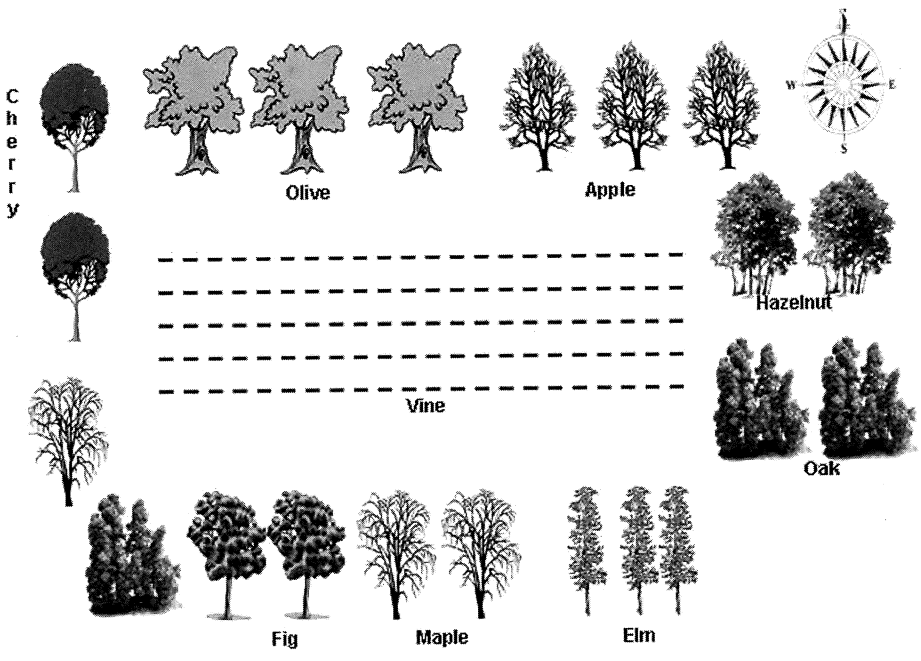

Fig. 1 - Schematic representation of the experimental field.

against powdery mildew was necessary in July 2002 using Fenarimol. The wood is mainly made up of *Quercus pubescens* Willd. (25 plants) and *Quercus ilex* L. (4 smaller plants).

As to pests, no problems were observed during the whole experimental period in this area.

No treatments had been effected in the experimental field for the previous ten years except for ordinary powdery and downy mildew management in the vineyard.

Phytoseiid mites were fortnightly collected from January 2001 to December 2002.

During the vegetative period 25 leaves were shaken at each sampling point and the mites were collected on black paper which had been placed underneath. In the winter the same procedure was applied but 25 cm long twigs were used (Tsolakis & Ragusa, 1999). Then, they were clarified in Nesbitt's solution and mounted on slides with Hoyer's fluid and identified at the phase-contrast microscope for species, sex and developmental stage.

The occupation of the phytoseiids was calculated considering the number of plants on which each species was found.

To calculate the similarity among the plants in the experimental field Sörensen's similarity index was used (Sörensen, 1948). The dendrogram of similarity was also constructed, by the UPGMA method (Unweighted Pair Grouping Method Using Arithmetic Averages), which takes into account the different species of mites found on the different plants of the experimental field.

The software SPSS was used for all statistical analysis and construction of the dendrogram (SPSS, 2000)[(1)].

RESULTS

Mites

Figure 2 shows the fluctuation of the entire phytoseiid mite population. In 2001 its density is low from January to just after mid May, then it rapidly increases to a maximum at the end of July. Probably the high temperatures in August restrict the population, but it increases during October and then, at the beginning of the winter, it becomes lower and lower until it reaches a minimum in December-January again. The same trend was observed in 2002, but there is a big difference between the population densities during the two winter seasons: maybe because the 2002 winter was unusually warm.

The following fifteen phytoseiid species were collected: *Kampimodromus aberrans* (Oud., 1930); *Euseius finlandicus* (Oud., 1915); *Kampimodromus langei* Waistein & Arutunjan, 1973; *Typhloctonus aceri* (Collyer, 1957); *Amblydromella crypta* (Athias-Henriot, 1960); *Amblydromella athenas* (Swirsky & Ragusa, 1976); *Typhlodromus baccettii* Lombardini, 1959; *Typhlodromus intercalaris* Liv. & Kutz., 1972; *Bawus talbii* (Athias-Henriot, 1960); *Typhloseiulus simplex* (Chant, 1956); *Typhlodromus pyri*

(1) SPSS 9.0 for Windows, 2000. SPSS Inc.

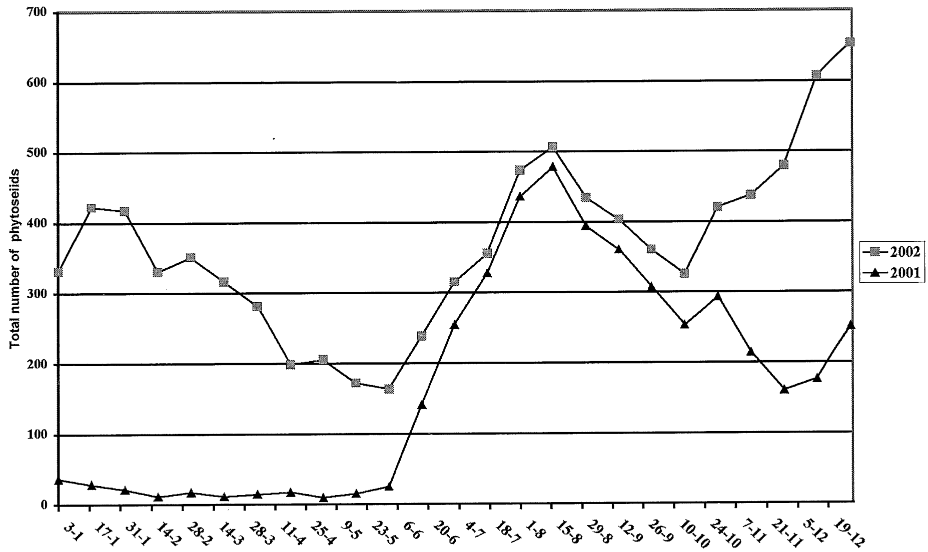

Fig. 2 - Fluctuation of the total phytoseiid mite population during the two years of investigation.

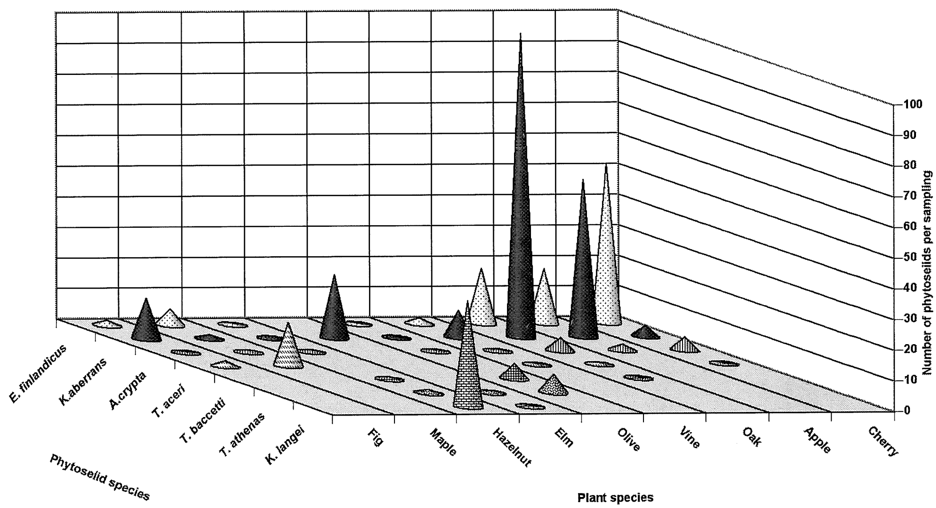

Fig. 3 - Population densities of the most widespread phytoseiid mite species in the experimental field.

Scheuten, 1857; *Seiulus eleonorae* Ragusa & Swirski, 1981; *Seiulus soleiger* Ribaga, 1902; *Seiulus amaliae* Ragusa & Swirski, 1976 and *Typhlodromus recki* Wanstein, 1958.

Figure 3 displays the differences among the population densities of the mite species found on the different plant species during the whole sampling period. The highest numerical value was obtained on oak, where the average number of phytoseiids were greater. The lowest value was found on olive. High population densities were also observed on apple trees, cherry and hazelnut. Instead, the average number of mites collected was lower on maple, elm and fig, and was very low on vine and olive.

The most widespread phytoseiid species was *K. aberrans*, found on all investigated plant species. It has the largest population density on oak and apple, but its populations are not negligible also on elm, fig and vine. The second species sampled, in order of dispersion, was *E. finlandicus,* found on all the plants species except the elm. It has the largest population density on cherry trees and its population was consistent also on oak, apple, maple and vine. *K. langei,* was present only on elm and hazelnut trees and, on this latter species, it was the most common phytoseiid mite. It was followed by: *T. aceri*, found especially on maple followed by fig, but also found on vine, oak and cherry trees. *A. crypta*, with a low population density, was found on all the plant species investigated, except the elm; *A. athenas*, collected mainly on olive trees, but sporadically found on elm and hazelnut too, whereas *T. baccettii* was found especially on olive trees and on hazelnut and oak (Table 1, Figs 3-4).

The other eight species were collected sporadically with a percentage of occupation, out of the total number, lower than 1% (Fig. 4).

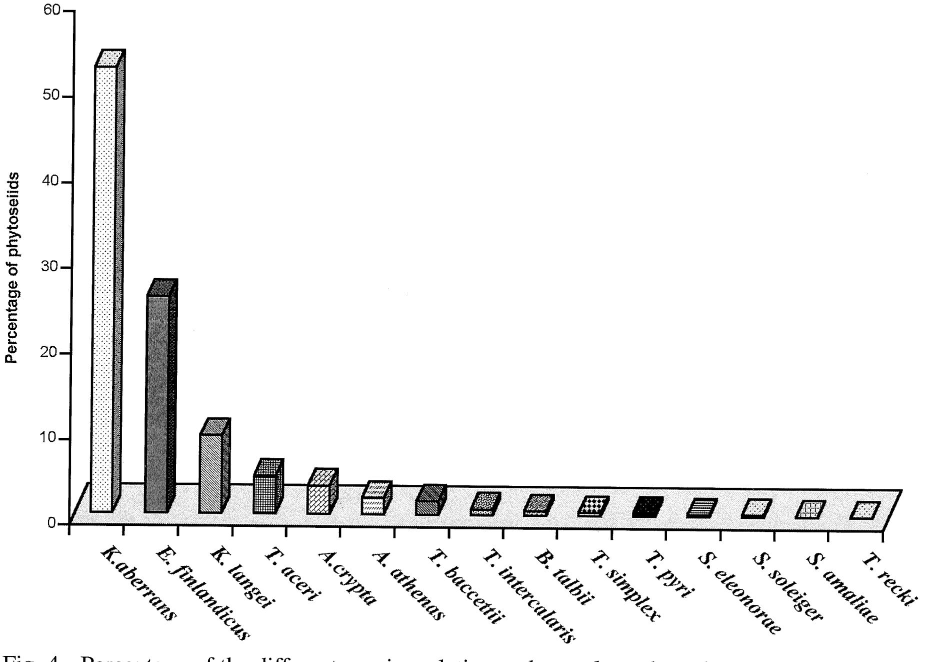

Fig. 4 - Percentage of the different species relative to the total number of phytoseiids out of the total sampling number.

Table 1 - Percentage of different phytoseiid mite species on different trees for two years of investigation.

	Cherry	Apple	Oak	Vine	Olive	Elm	Hazelnut	Maple	Fig	Frequency (%)
K. aberrans	6.06%	**71.08%**	**78.24%**	**74.30%**	2.52%	**95.05%**	1.22%	6.40%	**78.35%**	**100.0**
E. finlandicus	**86.29%**	24.55%	14.16%	16.38%	0.65%		0.85%	24.26%	9.87%	**88.8**
A. crypta	7.20%	2.83%	3.32%	3.24%	3.40%		1.33%	2.93%	1.09%	**88.8**
T. aceri	0.12%		0.35%	2.18%				**65.68%**	10.69%	**55.5**
B. talbii	0.14%	1.39%	0.20%		0.61%	1.89%				**55.5**
S. soleiger	0.18%	0.10%	0.22%	0.31%	2.14%					**55.5**
T. pyri			0.07%	2.65%	1.72%		1.87%			**44.4**
T. intercalaris		0.05%	1.45%				1.81%			**33.3**
T. athenas					**47.61%**	2.68%	2.56%			**33.3**
T. baccetti			0.20%		41.35%		1.80%			**33.3**
K. langei						0.38%	**88.56%**			**22.2**
S. simplex			1.06%							**11.1**
S. eleonorae			0.72%							**11.1**
S. amaliae								0.73%		**11.1**
T. recki				0.94%						**11.1**

* the highest values are placed in heavy type

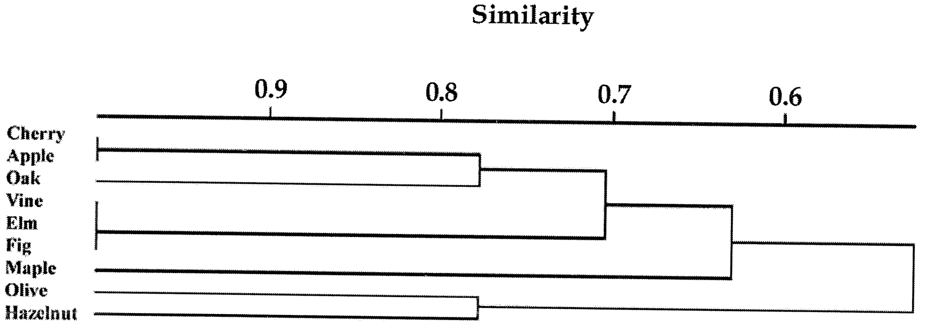

Fig. 5 - Dendrogram constructed upon the matrix of the Sörensen's similarity index using the UPGMA method.

In Table 1 it is possible to observe the frequency of occupation of the different phytoseiid mite species, elaborated by grouping the data of the different plant species: *K. aberrans* is present on all the plants sampled with a 100% occupation; *E. finlandicus* and *A. crypta* are present on eight trees out of nine, with an 88% occupation.

S. soleiger, *T. aceri* and *B. talbii* have been found on 5 plant species, with a 55.5% occupation. *T. pyri* is present on four plant species, with a 44.4% occupation. *A. athenas, T. baccettii* and *T. intercalaris* are present on three sampling points and all with a 33.3% occupation. *K. langei*, is present on only 2 kinds of trees and has a 22.2% occupation. *S. eleonorae*, *S. amaliae*, *S. simplex* and *T. recki*, were found just on one plant, with a 11.1% occupation.

Analysis

Sörensen's similarity index and its matrix (Table 2) were used to identify the high similarity among the nine different plant species and to find out if the border plants influenced the populations of phytoseiid mites present in the vineyard and in the whole experimental field. With the dendrogram, constructed upon the matrix of the Sörensen's similarity index, it is possible to identify two clusters, named respectively A and B (Fig. 5).

Cluster A can be divided into three sub-clusters: A_1, which includes cherry and apple (similarity: 100%), and the oak, that has a similarity of 75% with cherry and apple; instead, A_2 appears to be more homogeneous, because it is made up of three plant species (vine, elm and fig) that all have a 100% similarity among them. Sub-cluster A_3 includes only the maple, very distant from all the plants of the experimental field.

Cluster B is formed by olive and hazelnut, with a similarity of 50 % between them and are in no way related to the other plants of the experimental field.

Table 2 - Matrix of similarity distances among the different plants investigated.

Matrix of distances									
	Cherry	**Apple**	**Oak**	**Vine**	**Olive**	**Elm**	**Hazelnut**	**Maple**	**Fig**
Cherry		1.00	0.75	0.50	0.00	0.50	0.00	0.40	0.50
Apple	1.00		0.75	0.50	0.00	0.50	0.00	0.40	0.50
Oak	0.75	0.75		0.33	0.00	0.33	0.00	0.29	0.33
Vine	0.50	0.50	0.33		0.00	1.00	0.00	0.00	1.00
Olive	0.00	0.00	0.00	0.00		0.00	0.50	0.00	0.00
Elm	0.50	0.50	0.33	1.00	0.00		0.00	0.00	1.00
Hazelnut	0.00	0.00	0.00	0.00	0.50	0.00		0.00	0.00
Maple	0.40	0.40	0.29	0.00	0.00	0.00	0.00		0.00
Fig	0.50	0.50	0.33	1.00	0.00	1.00	0.00	0.00	

DISCUSSION

The results allow a broad in-depth view of the useful role of surrounding vegetation in the presence and spread of phytoseiid mites in agroecosystems. The fifteen phytoseiid mite species collected show the high diversity of this group of predators, due to the great variety of plants of the experimental field. Moreover, the presence and the frequency of occupation of the same mites on the same plants, confirms that there is plant-predator interaction.

The influence of surrounding spontaneous and cultivated trees on the presence and spread of phytoseiid mites in the cultivated areas is particularly evident when comparing the populations collected: *K. aberrans* was present on all the plant species investigated, whereas *E. finlandicus* and *A. crypta* were present on all plant species except the elm. *K. aberrans* had a high colonizing pressure on vine and on the whole experimental field, but also because of the presence of the oak wood, that has been demonstrated to be a reserve for this phytoseiid mite species in several previous works (Duso *et al.*, 1993; Favuel & Cotton, 1981; Tixier *et al.*, 1998, 2000a). *E. finlandicus* has been associated to the vine in vineyards similar to our experimental plot, in the D.O. region of Rías Baixas, northern Portugal (Pèrez Otero *et al.*, 1999). It has also been described as one of the most important predators of *Columerus vitis* in Alsace - western France (Ocete *et al.*, 2000) and it has been largely collected on nut trees, potato and tomato crops in the Campania region (Southern Italy) (Nicòtina *et al.*, 2002). *A. crypta* has been found in France (Kreiter, 1989), Spain (Villaronga & Ferragut, 1986), Greece (Swirski & Ragusa, 1976) and Israel (Amitai & Swirski, 1978). It has been observed, especially in Southern Italy (Sicily), to be associated to both wild and cultivated plants (Ragusa Di Chiara & Tsolakis, 1996).

Some species appear to be associated to few tree species: it's the case of *T. bac-*

cettii on olive and hazelnut, *T. aceri* on maple and fig. *K. langei*, instead, seems to be strictly linked to hazelnut (Nicòtina & Cioffi, 1999).

However, as all the phytoseiid mite species found in the experimental field were generalist predators, it can be hypothesized that pollen causes a strong development and colonization of the phytoseiid mites (Ragusa & Swirski, 1975; Ragusa, 1981).

The presence and spread of large populations of phytoseiid mites in the experimental field did not allow any outbreak of phytophagous mites or thrips, and this confirms that if these mites are not eradicated they are vitally important in keeping pest control strategy costs down.

In conclusion, this research confirms the usefulness of *K. aberrans* and *E. finlandicus* and the results of previous studies regarding the beneficial role of oak trees close to the vineyards which act as a reserve for these phytoseiid mite species (Duso & Fontana 1996; Tixier *et al.*, 2000b).

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