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Surveys of the populations of Phytoseiid mites in the vineyard and on natural vegetation(*)

Abstract - The results of a work whose aim is to highlight the existing interactions between the vineyard and natural vegetation with reference to the populations of Phytoseiid mites have been reported. The research was carried out in Lombardy in the viticultural area of Franciacorta, during 1997 and 1998 and in 2001. Samples were taken from the foliage of the cultivation and on the most abundant natural species and the passive aerial dispersal of the Phytoseiid mites was evaluated. The importance of trees in sustaining great populations of these predators was confirmed, among which there was *Kampimodromus aberrans* (Oud.) that dominates on the vine. The Phytoseiid mites were only sporadically found on grass except on *Urtica dioica* where two species were found; *Phytoseius* gr. *horridus* and, to a lesser extent, *K. aberrans*. The movement within the agro-ecosystem via air currents of the Phytoseiid mites present on tree vegetation was ascertained. The evolution of the colonisation of the vineyards was faster in the plots surrounded by wooded areas. The populations reached a very high density and were dominated by *K. aberrans*. Where there was only grass the populations of Phytoseiid mites remained low and was made up of vicarious species, such as *Amblyseius andersoni* (Chant) and *Typhlodromus pyri* Scheuten.

Riassunto - *Indagini sui popolamenti di Fitoseidi nel vigneto e sulla vegetazione spontanea.*

Si riportano i risultati di un lavoro volto a evidenziare le interazioni esistenti tra il vigneto e la vegetazione spontanea in riferimento ai popolamenti di Acari Fitoseidi. La ricerca è stata effettuata in Lombardia, nella zona viticola della Franciacorta, durante le annate 1997-98 e 2001. Sono stati effettuati campionamenti fogliari sulla coltura e sulle specie spontanee più abbondanti ed è stata valutata la capacità di dispersione passiva dei Fitoseidi. Si è confermata la rilevanza di piante arboree nel sostenere cospicue popolazioni di questi predatori, tra cui *Kampimodromus aberrans* (Oud.), dominante sulla vite. I ritrovamenti di Fitoseidi sulla flora erbacea sono stati sporadici tranne che su *Urtica dioica,* dove si sono raccolte 2 specie, *Phytoseius* gr. *horridus* e, in minore misura, *K. aberrans*. È stato accertato lo spostamento all'interno dell'agroecosistema per mezzo di

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correnti aeree dei Fitoseidi presenti sulla vegetazione arborea. L'evoluzione della colonizzazione dei vigneti è risultata più rapida negli appezzamenti circondati da fasce boschive. I popolamenti hanno raggiunto densità molto elevate e sono dominati da *K. aberrans*. In presenza di sola vegetazione erbacea le popolazioni di Fitoseidi sono rimaste poco numerose e costituite da specie vicarianti, quali *Amblyseius andersoni* (Chant) e *Typhlodromus pyri* Scheuten.

Key words: Phytoseiidae, vineyard, aerial dispersal, green cover, woods.

INTRODUCTION

The evolution of pest management strategies has been developed in the last years with the objective of obtaining control of pests at the same time as having a low environmental and economic impact. Until now this has led to integrated production (El Titi *et al.*, 1995; Malavolta & Boller, 1999; Boller *et al.*, 1999), one of whose fundamental components is habitat management. It is the adoption of management measures of the agro-ecosystem whose aim is to favour the balance of the crop. This strategy is based on the assumption, now consolidated, that the increase of the biological complexity of an agro-ecosystem raises its homeostasis favouring, usually, the increase of beneficial and indifferent species but certainly not the harmful ones (Remund *et al.*, 1992). On the whole the balance reached in this way lasts indefinitely and can only be upturned by the appearance of new exotic pests. This possibility has already happened twice for the vine in the last decades, with *Metcalfa pruinosa* (Say) and *Scaphoideus titanus* (Ball). The increase of the diversity must be aimed at favouring well-defined elements. For vine the critical factors, for now, are indicated for some trees and shrubs, relying upon the capacity of dispersal of the Phytoseiid mites that they host (Johnson & Croft, 1976, 1981; Hoy, 1982; Charles & White, 1988). Less is known about the role of grass. The application of such sophisticated strategies requires a deep knowledge of all the elements that characterise an agro-ecosystem and this has still not been obtained so far.

In this work the results of a study carried out in northern Italy on Phytoseiid mites are shown. The aim is to highlight the existing interactions between the vineyard, the spontaneous green cover and surrounding natural areas. In particular, to verify which grass and natural tree species host populations of Phytoseiid mites of practical interest and whether they can favour the colonisation and settlement of these predators in the vineyard.

MATERIALS AND METHODS

The observations were carried out in the years 1997, 1998 and 2001 in four vineyards in Franciacorta in eastern Lombardy. Their main characteristics are in table 1. They are three young vineyards and one in full production that represents the "standard vineyard" for the area. The vineyards are managed according the normal cultural

Table 1 - Characteristics of the experimental vineyards.

Parameter	**Vineyard I**	**Vineyard II**	**Vineyard III**	**Vineyard IV**
Location	Camignone	Ome	Gussago	Brescia
Area (ha)	3.00	0.80	0.60	0.60
Year of planting	1993	1991	1994	1970
Variety	Chardonnay, Pinot Blanc	Chardonnay	Cabernet Sauvignon, Merlot	Merlot
Grafting	101-14	420A	SO4	
Growth system	"Cordone speronato"	"Guyot"	"Guyot"	"Casarsa"
Planting	2.5 x 1	2.5 x 1.2	2.5 x 1	5 x 4
Row orientation	East - West	North - South	East - West	East - West
Soil management	Spontaneous green cover since 1994	Spontaneous green cover	Spontaneous green cover since 1996	Spontaneous green cover
Surrounding vegetation	Vineyard on all sides	Vineyard on all sides	Wood on one side, meadow, vineyard	Wood on two sides, vineyard, meadow

practices of the area. The first two are located in areas that are exclusively for vines, whereby the only natural vegetation is the spontaneous green cover between the rows. The others are located in less intensive areas where there are woods. In the first years, pest management only slightly used active ingredients toxic for Phytoseiid mites, both fungicides and insecticides (table 2). Since the year 2000 the obligatory control measures against *S. titanus* has led to the repeated use of organophosphorus compounds. In every plot sampling took place between the months of May and the end of September every fortnight in the first two years and monthly in 2001. The samples were made up of 100 fully developed leaves, collected in the middle or lower part of the foliage.

In every vineyard a survey was carried out on herbaceous vegetation. The technique proposed by Daget & Poissonet (1969) was followed. Proceeding along the row a "bayonet" is dropped at regular intervals and the plants that come into contact with this bayonet are identified and counted. The most representative species are mentioned in table 3. In plots III and IV a visual evaluation of the consistency of tree species was carried out and the results are in table 4. The sampling mainly included the most abundant dicotyledon plants and was normally carried out monthly. The Gramineae were not considered, as little suitable to host Phytoseiid mites. For every natural species a number of leaves between 20 and 100 was taken, according to the size (tables 3 and 4). The material thus collected was then checked under a stereoscopic microscope.

Due to the remarkable difference in the size of the leaves of the species studied, in order to simplify the comparison, the density as well as mites per leaf, it has also

Table 2 - Active ingredients and number of treatments applied in the vineyards investigated.

Active ingredients	**Vineyards I - III**	**Vineyard II**	**Vineyard IV**
	97 – 98 – 01	**97 – 98 – 01**	**97 – 98 – 01**
Azoxystrobin	0 – 3 – 0		
Copper	4 – 3 – 0	1 – 1 – 1	
Cymoxanil + Copper	1 – 0 – 0	3 – 0 – 3	3 – 0 – 4
Cymoxanil + Mancozeb	1 – 1 – 0	0 – 5 – 0	5 – 6 – 3
Dimethomorph + Mancozeb		3 – 3 – 3	
Metalaxyl + Copper	2 – 0 – 0		
Fosetyl-aluminium + Copper	0 – 0 – 4		
Fosetyl-aluminium + Mancozeb	0 – 0 – 2		
Dusty Sulphur	1 – 1 – 1		1 – 2 – 2
Wettable Sulphur	4 – 3 – 4	4 – 4 – 4	
Cyproconazole			4 – 6 – 2
Fenarimol			4 – 0 – 0
Penconazole + Sulphur		2 – 2 – 2	0 – 0 – 2
Propiconazole + Sulphur	2 – 0 – 2		
Triforine		1 – 2 – 0	
Procymidone	2 – 0 – 0		
Fenitrothion	1 – 0 – 2	0 – 0 – 2	
Chlorpyriphos-methyl			0 – 0 – 2

Table 3 - Percentage composition of herbaceous flora in the experimental vineyards.

Species (number of leaves per sample)	**Vineyard I**	**Vineyard II**	**Vineyard III**	**Vineyard IV**
I *Centaurea transalpina* (50)				7.3
II *Convolvulus arvensis* (50)	*	*	6.4	*
III *Geranium molle* (50)				5.9
IV*Plantago lanceolata* (50)	8.2	*	6.7	12.1
V *Plantago major* (50)	6.1	*	5.5	*
VI *Potentilla reptans* (100)	*	15.8	10.2	10.3
VII *Ranunculus bulbosus* (50)		18.4		
VIII *Rumex* sp. (30)	*	5.3	5.3	*
IX *Taraxacum officinale* (30)	14.8	*	13.3	6.7
X *Trifolium pratense* (100)	*	*	*	6.0
XI *Trifolium repens* (100)	16.3	*	*	*
XII *Urtica dioica* (50)		*		4.4
Gramineae	40.7	41.8	38.3	32.1
Other species and clear soil	13.9	18.7	14.3	15.2

* = species included in "other species"

Table 4 - Percentage composition of woods surrounding the experimental vineyards and average area of a leaf.

Species (number of leaves per sample)	**Mean leaf area cm^2 ± st. dev.**	**Vineyard III**	**Vineyard IV**
Hackberry - *Celtis australis* (100)	26.4 ± 7.8		25
Cornelian Tree - *Cornus mas* (100)	20.0 ± 5.8	25	10
Hazelnut - *Corylus avellana* (50)	49.7 ± 25.9	20	
Fig tree - *Ficus carica* (20)	231.6 ± 74.2	10	8
Manna ash - *Fraxinus ornus* (35)	120.8 ± 36.9	30	*
Walnut tree - *Juglans regia* (20)	171.8 ± 65.1	7	10
Blackberry bush - *Rubus* sp. (35)	85.5 ± 20.0	*	8
Elder - *Sambucus nigra* (20)	178.9 ± 46.7		10
Elm - *Ulmus* sp. (100)	23.8 ± 6.1		20
Other species		8	9
Grapevine	120.6 ± 40.4		

* species included in "other species"

been expressed as mites per square decimetre. For this reason, the size of a "standard leaf" was calculated for each species measuring the area of 100 leaves, using the programme Sigma Scan Pro®. The values for trees and shrubs are reported in table 4. In this way it was possible to obtain the density per unit of area. As the data obtained in this manner is approximate, it was decided to express it in terms of "class of density" (table 5) rather than the numerical value really obtained.

Passive dispersal from tree vegetation via air currents was evaluated using plastic funnels with a diameter of 40 cm. They were placed above the vegetation at a height of about 2.5 metres, filled with water to which a surface-active agent (1‰) and formaldehyde (5‰) were added in order to favour the sedimentation and conservation of the mites. The test was carried out in 1998 in vineyard III that had been almost without

Table 5 - Classes of density per unit of area.

Density (mites per dm^2)	**Classes**
5 - 10	IV
2 - 5	III
0.5 - 2	II
0 - 0.5	I
0	0

any Phytoseiid mites the year before. Four funnels were placed one in each of the first four rows. The distance from the wooded area was between 2.5 and 10 metres. The funnels were installed on 20 May and were left in function until 4 August. The first check was made a month after placing them and later every fortnight. In 2001 the test was not repeated, as the Phytoseiid mites present in the vineyard would have interfered with the evolution of the experiment.

RESULTS

The data relative to the observations carried out in the three years are mentioned in tables 6-9 and in figure 1. Three out of the 12 grass species checked were without Phytoseiid mites (*Convovulus arvensis*, *Geranium molle* and *Trifolium repens*) (table 6). *Urtica dioica*, only collected in 2001, instead hosted a stable population mainly made up of a species of *Phytoseius* of the group *horridus*, with an average density of 0.32 mites/leaf, equal to about 1.4 individuals/dm^2 (average area of the leaf is 22.6 ±

Table 6 - Presence of Phytoseiid mites on grass. Samples / samples with Phytoseiid mites and Phytoseiids collected.

1997

	Species	I	II	III	IV	VI	VII	VIII	IX	X	XI
Vineyards	I								5/0		6/0
	II					5/0	5/1 3 n	5/0			
	III		5/0		6/0	5/1 1 n			5/0		
	IV	4/0		5/0	6/0	5/0			6/0	6/0	

1998

	Species	I	II	III	IV	VI	VII	VIII	IX	X	XI
Vineyards	I								4/0		6/0
	II					5/1 2 Aa	4/0	4/0			
	III		4/0		5/0	5/0			4/0		
	IV	5/1 1 Ka		4/0	6/0	4/0			6/0	5/1 3 n	

2001

	Species	I	IV	V	VI	VII	VIII	IX	XI	XII
Vineyards	I		5/1 1 Ka	4/0				5/1 1 n	5/0	
	II				5/2 5 Aa, 1 n	4/1 1 Aa, 1 n	5/0			
	III		5/0	4/1 1 n	4/0		4/0	5/0		
	IV	4/0	5/2 1 Ka, 1 n		5/1 1 Ef		4/1 1 Ka, 2 n	5/0		5/5 42 Phh, 7 Ka, 32 n

Aa = *A. andersoni*; Ef = *E. finlandicus*; Ka = *K. aberrans*; Phh = *Ph.* gr. *horridus*; n = nymphs

Table 7 - Presence of Phytoseiids on trees and shrubs.

	Species	Presence/ Samples	Mites per leaf/ mites per dm²	Nr of mites	Percentage Aa	Ef	Ka	Ps	Pt	Tp
1997										
Vineyard III	*Cornus mas*	1 / 3	0.06 / I	19		100.0				
	Corylus avellana	4 / 4	3.06 / IV	612			98.6			1.4
	Ficus carica	3 / 4	3.10 / II	248			94.9		5.1	
	Fraxinus ornus	1 / 5	0.07 / I	12			100.0			
	Juglans regia	1 / 3	0.28 / I	17	69.2				30.8	
Vineyard IV	*Celtis australis*	7 / 7	1.53 / IV	1068		7.3	92.7			
	Cornus mas	2 / 4	0.08 / I	33			100.0			
	Ficus carica	7 / 7	2.03 / II	284	4.4		95.6			
	Juglans regia	2 / 5	0.44 / I	44		55.6	44.4			
	Rubus sp.	1 / 5	0.24 / I	42		100.0				
	Ulmus sp.	4 / 4	0.96 / III	383		76.8	23.2			
1998										
Vineyard III	*Cornus mas*	3 / 5	0,36 / II	178		63.2	36.8			
	Corylus avellana	5 / 5	1,97 / III	492			97.6			2.4
	Ficus carica	3 / 4	2,11 / II	169			100.0			
	Fraxinus ornus	2 / 6	0,30 / I	64		23.8	76.2			
	Juglans regia	3 / 4	1,76 / II	141	24.8	32.4	15.2		27.6	
Vineyard IV	*Celtis australis*	7 / 7	2,51 / IV	1755		1.9	98.1			
	Ficus carica	5 / 7	0,94 / I	131			100.0			
	Juglans regia	3 / 5	2,04 / II	204		76.6	23.4			
	Sambucus nigra	5 / 5	6,53 / III	653		91.0	9,0			
	Ulmus sp.	3 / 5	0,43 / II	214		61.7	38.3			
2001										
Vineyard III	*Cornus mas*	5 / 5	0,58 / III	290		86.8	9,4	3,8		
	Corylus avellana	4 / 4	3,14 / IV	628		6.0	83,6			10,4
	Ficus carica	4 / 4	1,64 / II	131			100,0			
	Fraxinus ornus	4 / 4	0,42 / I	59		30.8	53,8	15,4		
Vineyard IV	*Celtis australis*	4 / 4	2,16 / IV	864			98,7		1,3	
	Juglans regia	4 / 4	2,40 / II	192		83.6	16,4			
	Sambucus nigra	3 / 4	1,77 / II	142		98.7				1,3
	Ulmus sp.	3 / 4	0,16 / II	64		100.0				

Presence / samples = number of samples with presence of Phytoseiids / total number of samples
Aa = *A. andersoni*; Ef = *E. finlandicus*; Ka = *K. aberrans*; Ps = *P. soleiger*; Pt = *P. talbii*; Tp = *T. pyri*

Table 8 - Captures with funnel traps. Vineyard III, 1998.

	A. andersoni	***E. finlandicus***	***K. aberrans***	***P. talbii***	***T. pyri***	***Pre-immaginal stages***	**Total**	**Mites / m² day**
20 June	0	16	11	1	0	1	29	1.86
4 July	0	15	9	0	1	5	30	4.26
20 July	1	13	9	0	0	1	24	2.98
5 August	0	12	9	1	1	0	23	2.86
Total	1	56	38	2	2	7	106	2.77

Table 9 - Presence of Phytoseiid mites on grapevine in the experimental vineyards.

Vineyard	**Vineyard I**			**Vineyard II**			**Vineyard III**			**Vineyard IV**		
Year	1997	1998	2001	1997	1998	2001	1997	1998	2001	1997	1998	2001
Samples with Phytoseiids / total samples	4/10	6/10	5/5	9/10	8/10	5/5	8/10	10/10	5/5	10/10	10/10	5/5
Annual average density mites/leaf	0.017	0.024	0.274	0.123	0.075	0.384	0.179	0.258	4.374	1.172	1.271	5.136
Mites/dm^2	I	I	I	I	I	I	I	I	III	II	II	IV
Nr of Phytoseiids	17	24	137	123	75	192	179	258	2187	1172	1271	2568
A. andersoni %	66.7	85.7	76.1	42.1	62.7	4.3	2.8	0.9		0.4		
E. finlandicus %	11.1			5.3	3.4		83.9	47.7		2.0	1.4	1.1
K. aberrans %			3.4	10.5	3.4	2.6	2.8	51.4	98.9	94.2	98.2	98.9
P. talbii %	22.2			14.7	16.9	7.8	9.1		0.8	3.0	0.4	
Ph. macropilis %				5.3	13.6							
T. pyri %		14.3	20.5	22.1		85.3	1.4		0.3	0.4		

6.1cm^2). The greatest presence was recorded on 28 June (0.88 mites/leaf). The other types of grass showed sporadic presence of predators as well as being very modest in numbers. On the whole 27 specimens of *Amblyseius andersoni* (Chant), *Kampimodromus aberrans* (Oud.) and *Euseius finlandicus* (Oud.) have been collected (table 6).

In 1997, 5 species of the Phytoseiids were collected on trees. *K. aberrans* was the most abundant and frequent, followed by *E. finlandicus*. *Typhlodromus pyri* Scheuten was present on hazelnut, *Paraseiulus talbii* (Athias-Henriot) on walnut and on fig trees, *A. andersoni* on walnut. The major densities were recorded for hazelnut and hack-

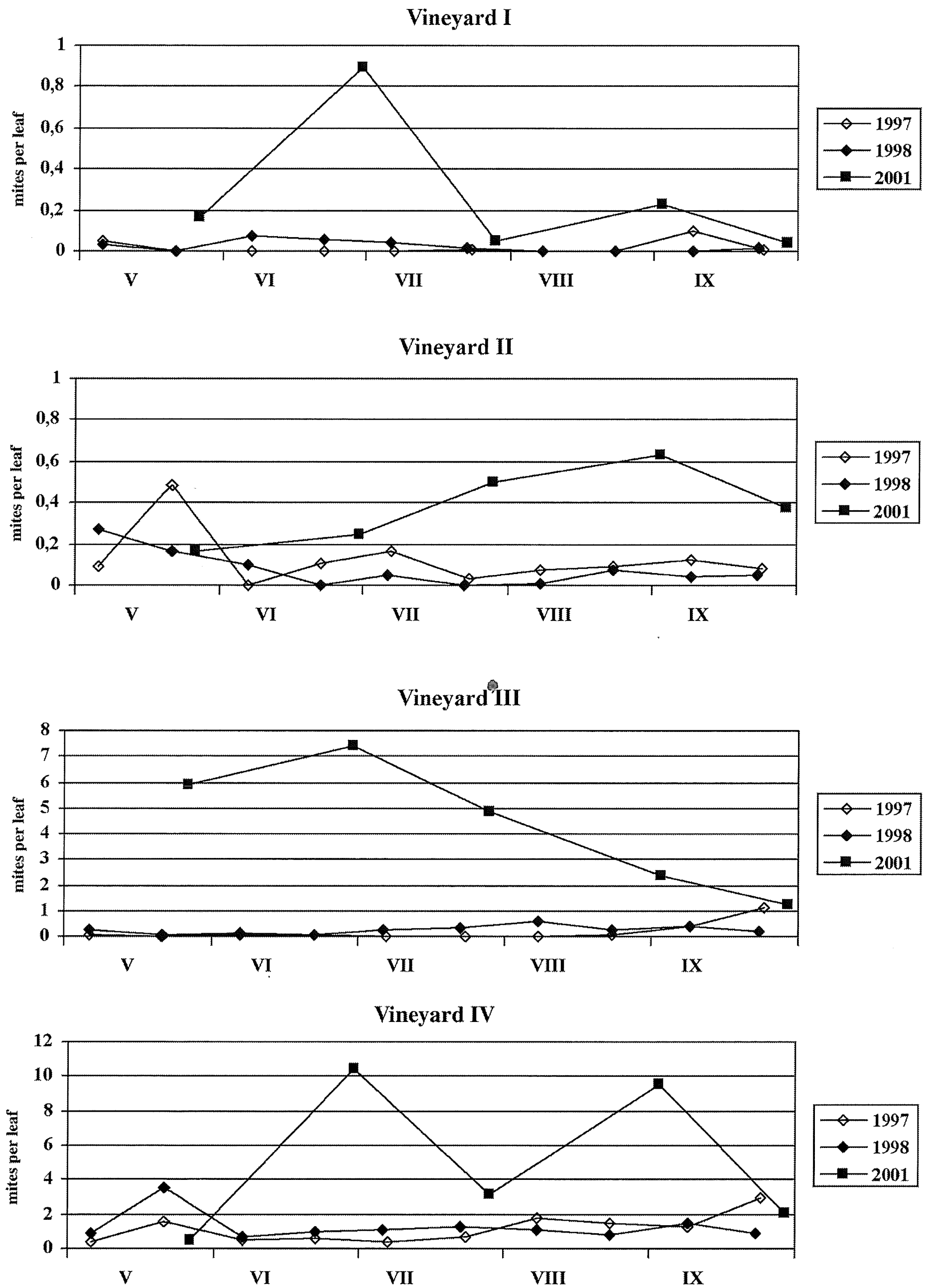

Fig. 1 - Dynamics of the populations of Phytoseiid mites in the experimental vineyards.

berry-tree, followed by the elm (table 7). In 1998 the same species were present with a similar distribution and abundance. The highest populations were the ones of hackberry-tree, hazelnut and elder. In 2001 5 species were still collected. The most important were still *E. finlandicus* and *K. aberrans*. *Paraseiulus soleiger* (Ribaga) was found on cornelian tree and manna ash; *P. talbii* on hackberry-tree; *T. pyri* on hazelnut and elder. All the species sampled highlighted a stable presence of Phytoseiid mites. The highest densities were reached on hackberry-tree, hazelnut and on cornelian tree.

In 1998, thanks to funnel traps, 106 specimens were collected on the whole in 76 days, with an average of approximately 2.8 individuals per day per square metre (table 8). The specific division corresponds to the one found on natural tree vegetation with a clear superiority of *E. finlandicus* and K. *aberrans* and three other species sporadically present (*T. pyri*, *P. talbii* and *A. andersoni*).

The data relative to the sampling on the vine is written in table 9 and in figure 1. In vineyard I the presence of Phytoseiid mites in 1997 and 1998 was sporadic. In 2001 the plot was colonised permanently by a small population dominated by *A. andersoni* that was always present. Vineyard II recorded a low and unstable presence of Phytoseiid mites in 1997 and 1998. Only one of the species present, *A. andersoni* was collected with some frequency. In 2001 the population dominated by *T. pyri* was stable and quite consistent. In vineyard III, in 1997 the Phytoseiid mites, almost absent in summer, appeared in great number in September. Over 80% were made up of *E. finlandicus*. The following year the colonisation was permanent but little consistent. *K. aberrans* was the most numerous at the end of the season, *E. finlandicus* at the beginning. In 2001 the whole population was very high with a maximum level at the end of June. *K. aberrans* was practically the only species present. Vineyard IV recorded a constant presence of Phytoseiid mites in all the years and high densities. *K. aberrans* has always dominated, being almost the only species present.

DISCUSSION

The data collected highlights how the herbaceous flora has practically no Phytoseiid mites. These results are in part contrasting with what has been reported in literature. Different Authors (Ragusa & Paoletti, 1985; Costa-Comelles *et al.*, 1994; Stanyard *et al.*, 1997; Nicotina *et al.*, 2002) have signalled a significant presence of Phytoseiid mites on green cover in different agro-ecosystems. Fischer-Colbrie & El-Borolossy (1989) and Lozzia & Rigamonti (1998) have instead noticed their high presence in abandoned apple orchards or vineyards and their total absence in cultivated ones. A possible explanation for the scarce presence of Phytoseiid mites found in this research can be due to the scarce number of preys. Only the nettle was infested by phytophagous arthropods and it is the only plant that hosted populations of Phytoseiid mites worthy of note. Furthermore, the density of predators was higher in the first part of the season in correspondence to the higher concentrations of phytophagous insects. The dominating species, *Ph.* gr. *horridus*, is not among the ones able to colonise the vine. However, Sommaggio *et al.* (1995) have highlighted how nettle is very receptive, able to host numerous species of Phytoseiid mites, in particular those of natural trees and shrubs surrounding it, amongst which some are of remarkable interest. The nettle can therefore carry out an interesting role as reservoir for Phytoseiid mites even if, at least in the examined environments, it has a clearly limited diffusion, which lowers its practical interest. In order to clarify the potential role of grass it would be useful to verify the effects of an aimed spontaneous green cover with few species suitable for Phytosend mites colonisation, maybe located solely on the borders of the vineyard, and so less likely to be influenced by cultural practices.

The importance of many species of trees and shrubs as hosts for Phytoseiid mites has been known for a long time. However not all the plants have the same practical relevance, as some can host scarce or fluctuating populations, or Phytoseiid mites that are not able to colonise vine (Collier, 1956; Chant, 1959; Fauvel & Cotton, 1981; Solomon, 1981; Boller *et al.*, 1988; Lozzia & Rigamonti, 1990; Coiutti, 1993; Duso *et al.*, 1993). The observations confirm what has just been written and have allowed to single out the most interesting species for this area. The most frequent and abundant Phytoseiid mites are *K. aberrans* and *E. finlandicus* that seem to prefer plants with hairy and glabrous leaves respectively (Collier, 1956; Chant, 1959; Coiutti, 1993; Duso *et al.*, 1993). Only the first species is dominant on vine, too. Of the nine species analysed; the most important are hackberry-tree and hazelnut that are widespread and colonised by high and stable populations over the years of *K. aberrans*. Furthermore there is a presence, of secondary importance but constant, on hazelnut of *T. pyri*, which is another Phytoseiid mite of great importance on vine. The fig tree is also interesting and is often found on the borders of vineyards and other cultivations, both planted on purpose and natural. It also hosts *K. aberrans* but at clearly lower densities than those found on the previous species, about 1 specimen/dm^2 against 5 or more. All other plants are of little importance because they are scarcely colonised (manna ash), or because the populations are dominated by *E. finlandicus* (elm, elder) or for both reasons (cornelian tree, walnut, blackberry bush).

These observations become more important in the light of certain passive dispersal of the predators. In the experimenial area the Phytoseiid mites spread by aerial dispersal and the aptitude to dispersal is found in a uniformed way, in all the species settled in the agro-ecosystem. The quantity of specimens involved is relevant, reaching peaks of interception of over 4 mites per square metre a day and with an average over 2 a day. This means that in one year on a hectare of vineyard, some millions of specimens can land, most of which are *K. aberrans*. This data coincides with what has been found in France where it has been verified that this is the main form of dispersal and that *K. aberrans* and *T. pyri* are ubiquitous constituents of the aeroplankton (Tixier *et al.*, 1998, 2000).

The considerations suggested by the surveys on natural flora and passive dispersal are confirmed by the results of the observations on the vine. The vineyards I and II, located in areas without woods, although starting from similar situations to vineyard III and managed in the same way, evolved in a completely different way. From a starting point of colonisation that is not permanent through to a permanent population, although very restricted and made up of vicarious species in 2001 (*A. andersoni* and *T. pyri*) while *K. aberrans* is almost completely absent. In these environments Phytoseiid mites can colonise the vineyard almost exclusively by active dispersal or by phoresy (Sabelis & Dicke, 1985), mainly coming from the lots nearby. In these conditions *A. andersoni* was the most favoured as it has greater aptitude to dispersal (Jung & Croft, 2001). Since in correctly managed vineyards, as in the one in question, there is no adequate supply of food due to the lack of Tetranychidae and other mites, its populations remain limited and are subject to decline and disappear (Genini *et al.*, 1983; Strapazzon & Rensi, 1989). This situation persists until the arrival of Phytoseiid mites that are "prey independent". They are usually dominant on the vine (in northern Italy they are *K. aberrans* or *T. pyri*) and they take over. Certain factors, as a variety with hairless leaves, an irrational use of pesticides, high temperatures etc. favour *A. andersoni* at the expense of other species (Duso *et al.*, 1991; Duso, 1997; Duso & Vettorazzo, 1999). In this case the process of substitution can require a long time. In vineyard I *A. andersoni* still prevailed in 2001, 4 years from the start of the research and 8 from the planting.

Vineyard III, that borders on wood, evolved quickly and completely during the years of the experiment that has led to a fully balanced situation. At first it was an unstable settlement and the prevailing species was one not typical in the vineyard agroecosystem (*E. finlandicus*). Already after one year there were the first indications of change with a reduced but stable colonisation and a slight dominance of *K. aberrans*. In 2001 the picture fully corresponded to the condition of maturity for this area illustrated by vineyard IV, with high populations and almost exclusive presence of *K. aberrans*. The presence of trees and shrubs has led to a rapid colonisation of the species typical of the vine. The strips of trees act at the same time, as reservoirs of predators and as windbreaks, making the fall to the ground of aeroplankton easier. What has just been written highlights the remarkable potential of practices of environmental management whose aim is to favour certain plants. These measures can concern the planting of appropriate trees and shrubs (Boller *et al.*, 1988), but also the sowing of grass, which is a source of food (preys, pollen) (McMurtry, 1982; Duso *et al.*, 1993). Generalised indications cannot be given, though, as such practices are subjected to interferences of various nature that can question their validity. The association between hazelnut and *K. aberrans* is, for example, one of the most well known and ascertained in Italy (Ragusa, 1974; Duso & Sbrissa, 1990; Coiutti, 1993; Tsolakis *et al.*, 2000), but in some areas this plant loses importance as *K. aberrans* is substituted by a similar species or, as in Valtellina (Lombardy), it doesn't host Phytoseiid mites (Duso *et al.*, 1993; Lozzia & Rigamonti, 2002). The solutions must be found for each case individually and on the basis of specific surveys.

CONCLUSIONS

The observations have confirmed the importance of the population of Phytoseiid mites on trees such as the hackberry-tree, hazelnut and fig tree. The spontaneous green cover is of little importance. Only *Urtica dioica* hosts consistent populations. Aerial dispersal, which prevails in woody areas, represents the main means through which Phytoseiid mites reach new plantations or vineyards without any settlements. In such environments colonisation is quick and the vineyards rapidly reach maturity. In monocultural areas vicarious species dominate (*A. andersoni* and *T. pyri*) and evolution is much slower.

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