AFPP - 2e COLLOQUE INTERNATIONAL SUR LES ACARIENS DES CULTURES
MONTPELLIER - 24 ET 25 Octobre 2005

PREDATORY MITE POPULATION DYNAMICS IN VINEYARDS: THE ROLE OF ALTERNATIVE FOODS

A. Pozzebon*, C. Duso* and V. Malagnini **

*Dipartimento di Agronomia Ambientale e Produzioni Vegetali – Università degli Studi di Padova – viale dell'Università, 16 35020 Legnaro (PD) – Italy. alberto.pozzebon@unipd.it

** Dipartimento Difesa delle Colture - Istituto Agrario San Michele all'Adige – via E. Mach, 1 38010 San Michele all'Adige (TN) – Italy.

SUMMARY:
Field observations and laboratory trials showed that the availability of alternative foods can affect markedly the population dynamics of predatory mites. In north-eastern Italy, the persistence of predatory mites on cultivated grapes in condition of prey scarcity is influenced by the presence of pollen grains and grape pathogenic mildews on leaves. Evidence that two species of predatory mites (i.e. *Amblyseius andersoni* and *Typhlodromus pyri*) can develop and reproduce by feeding on pollen and fungi is reported.

Key words: Predatory mites, phytoseiids, alternative foods, pollen, grape pathogenic mildews.

RESUME:
DYNAMIQUE DES POPULATIONS D'ACARIENS PREDATEURS DANS LES VIGNOBLES: ROLE DES NOURRITURES ALTERNATIVES

Des observations de terrain et des essais en laboratoire ont montré que la disponibilité de nourritures alternatives peut affecter de façon importante la dynamique des population d'acariens prédateurs. Dans le Nord-Est de l'Italie, le maintien des populations d'acariens prédateurs en absence de proies est influencé par la présence de pollen et de mildiou sur les feuilles. Ce travail montre que deux espèces d'acariens prédateurs (i.e. *Amblyseius andersoni* et *Typhlodromus pyri*) peuvent se développer et se reproduire en se nourrissant de pollen et de champignons.

Mots-clefs : Acariens prédateurs, Phytoseiidae, nourriture alternative, pollen, mildiou de la vigne

Introduction

Phytoseiid mites (Acari Phytoseidae) play an important role in the biological control of phytophagous mites in several agro-ecosystems (Helle & Sabelis, 1985). Among them, *Typhlodromus pyri* Scheuten and *Amblyseius andersoni* (Chant) are common species in grapevine areas in Europe and North America. They are considered as generalist predatory mites because of their ability to feed on various food sources other than mite preys (e.g. pollen, honeydew, fungi, and insects) (McMurtry & Croft, 1997). These two species can control numerous tetranychid and eriophyid mite species in European vineyards (Schruft, 1985; Duso & de Lillo, 1996). On perennial crops such grape, long term persistence and survival of predatory mites even in absence of prey are key factor in successful spider mite control strategies (Nyrop *et al*, 1998).

During the last two decades, several studies emphasized the role of alternative foods for generalist phytoseiids on grapes. *T. pyri* and *A. andersoni* can develop and reproduce by feeding on pollen (Boller & Frey, 1990; Duso & Camporese, 1991; Schausberger, 1992) and pollen availability is crucial for the persistence of phytoseiid populations in fields (Eichhorn & Hoos, 1990; Wiedmer & Boller, 1990; Engel & Ohnesorge, 1994; Duso *et al*., 1997; Duso *et al*., 2002). Recent studies report on phytoseiid population increases related to the presence of Grape Downy Mildew (GDM) foliar symptoms (Duso *et al*., 2003) suggesting for *Plasmopara viticola* (Berk. & Curtis ex De Bary) Berlese & De Toni the role of alternative food for *A. andersoni* and *T. pyri* in vineyards. However, is not clear if downy mildew can support phytoseiid development and oviposition. In the present work relationships between the availability of alternative food and predatory mite population dynamics are reported. The results of laboratory trials are also discussed in order to support the importance of pollen and fungi for *A. andersoni* and *T. pyri* in vineyards.

Material and methods

Amblyseius andersoni and *T. pyri* populations were monitored in a vineyard (approximately 1 hectare; cv. Prosecco) located in the Treviso area (North-East of Italy) during three growing seasons, i.e. from 1998 to 2000. In preliminary samples the vineyard was colonized by *T. pyri* and *A. andersoni*. Leaf samples were collected approximately every 14 days by removing 10 leaves (1 leaf per plant taken from the mid part of shoots). Most of the pesticides used in the vineyard were selective to phytoseiid mites. Leaves were transported to the laboratory where mite densities were evaluated using a dissecting microscope. These leaves were also employed to assess pollen abundance by using an analysis described in Duso *et al*. (2002). Leaf symptoms of GDM were estimated using a 1 cm^2 scale printed transparent.

Laboratory trials were settled up to calculate developmental times and oviposition rates of *T. pyri* and *A. andersoni* reared on three different treatments: *Papaver roeas* pollen, GDM mycelium and control. The experimental units consisted of grape leaf disks (2 cm in diameter) cut from inter-vein area of leaves with or without GDM symptoms and supported bottom side up on wetted cotton. Disks without GDM symptoms were used for pollen and control treatment. Phytoseiid eggs collected from a laboratory colony maintained with pollen were used at the beginning of the experiment and placed singly on disks. The units were observed every 12 hours to record developmental stage changes. Pollen was added every two days. GDM mycelium was added by placing a new leaf disk with symptoms near to the old one every 2 days. In order to avoid area effects, a new leaf disk was placed in all other treatments. The new disks were placed in order to allow mites to move from one to the other disk. Trials involved 12 eggs per treatment (pollen, GDM and control). Disks were placed in climate chambers held at 20°C, 80 % RH and 16:8 photoperiod.

T. pyri and *A. andersoni* oviposition rates were calculated on leaf disks provided with pollen, showing GDM symptoms or on control disks without food. Different treatments were settled up and managed like in previous experiments. At the beginning of the experiment one young female and one adult male were placed on each unit. The number of eggs laid was counted daily per 10 days.

Data from field observation were analyzed using a linear regression. Developmental times and oviposition rates obtained in laboratory trials were analyzed using ANOVA and mean were separated with Duncan's test (P = 0.05).

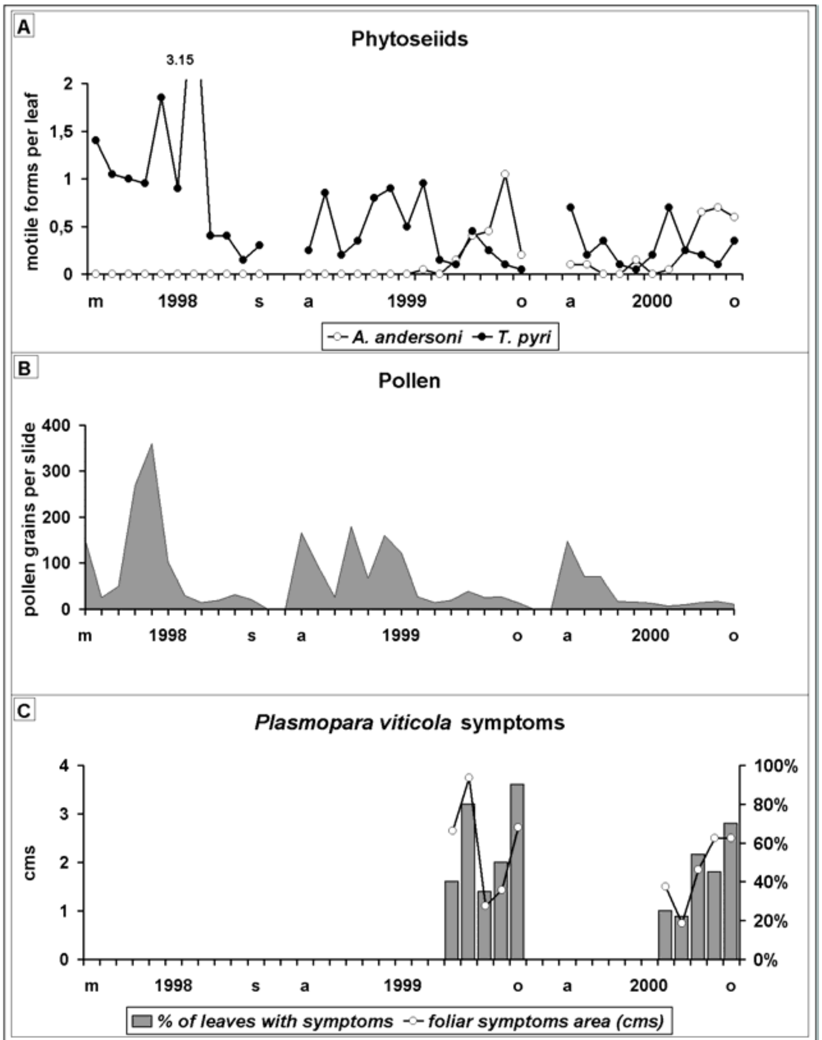

Figure 1: Predatory mite population dynamics (A), Pollen grains densities (B) and Grape downy mildew incidence(C) in commercial vineyard (cv. Prosecco) from 1998 to 2000.
Figure 1: Dynamiques des populations d'acariens prédateurs. Impact (A) des densités des grains de pollen (B) et du mildiou dans des vignobles commerciaux (cv. Prosecco) de 1998 à 2000.

Results

Phytoseiid dynamics, pollen availability and downy mildew spread in commercial vineyard

During 1998, *T. pyri* populations were recorded at highest densities in July while *A. andersoni* was rarely found (fig. 1A). Phytoseiid densities declined in the second part of summer. Pollen densities showed similar patterns: they reached their highest level in spring and the lowest during summer (fig 1B). Pollen densities peaked two weeks before the peaks of *T. pyri* populations. Grape downy mildew foliar symptoms were no detected (fig 1C).

Throughout 1999 growing season both *T. pyri* and *A. andersoni* were continuously recorded (fig 1A). In spring and summer samples *T. pyri* was dominant over *A. andersoni* but its densities declined in late summer. Pollen densities were recorded at relatively high levels in spring declining during summer (fig 1B). *T. pyri* densities fluctuated showing increases after pollen peaks. *A. andersoni* was found especially from August onwards and its populations increased in September when GDM symptoms spread on leaves. In the same period *A. andersoni* became dominant over *T. pyri*. GDM mildew foliar symptoms were recorded from late August until the end of the growing season (fig. 1C).

One year later, *T. pyri* was more abundant than *A. andersoni* in the first part of the season but the opposite was observed in late summer (fig. 1A). *T. pyri* densities were higher in spring when pollen was more abundant (fig. 1B). In 2000, GDM symptoms were commonly observed on the vegetation from August onwards (fig. 1C).

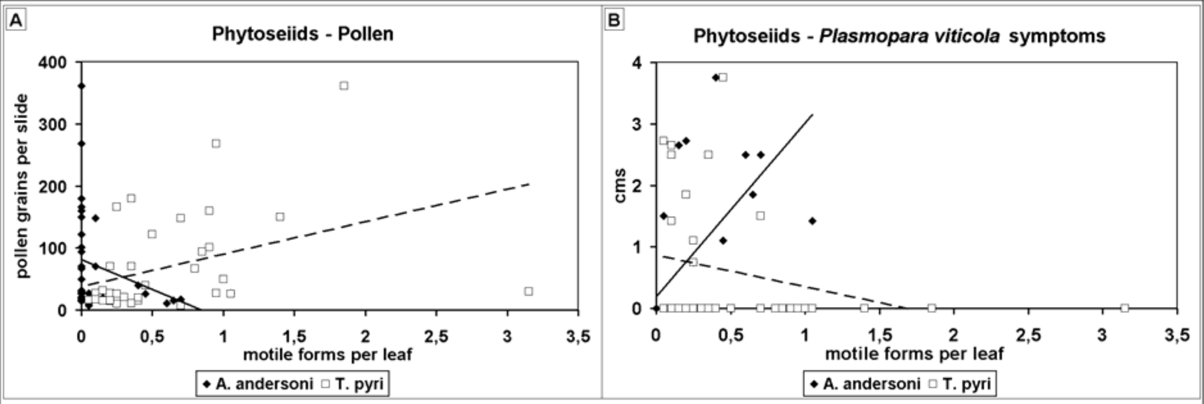

Figure 2: Linear regression of average number of phytoseiids and average number of pollen grains (A) and average number of phytoseiids and average Grape downy mildew extent during the three observing seasons. Broken lines denote expected value for *T. pyri* densities and full lines denote expected value for *A. andersoni* densities.

Figure 2: Régression linéaire entre le nombre moyen de phytoséiides et (A) le nombre moyen de grains de pollen, (B) le développement du mildiou durant 3 saisons. Les traits en pointillés concernent les densités de *T. pyri* et les traits pleins les densités de *A. andersoni*.

T. pyri population densities recorded on leaves during the overall observed seasons was positively correlated with the pollen densities detected on leaves (R^2 = 0.26; p = 0.01) (fig. 2a). In contrast a no significant linear relation was observed between *T. pyri* densities and GDM leaf symptoms extent (R^2 = 0.08; n.s.) (fig. 2b). On the other hand *A. andersoni* population densities appeared to be positively related to the GDM leaf symptoms extent (R^2 = 0.46; p < 0.01) (fig. 2b) and not significantly correlated to pollen densities (R^2 = 0.09; n.s.) (fig. 2a).

Laboratory trials

In laboratory trials both *T. pyri* and *A. andersoni* individuals never develop to the adult stage in the control.

T. pyri females develop significantly faster from egg to adult stage on pollen (157.33 hours) than on GDM mycelium (170.92 h). Concerning *T. pyri* males, no significant differences were observed between development times on *Papaver roeas* pollen (160.5 h) and GDM mycelium (165.33 h). Oviposition rates were significantly higher for females fed on pollen (1.12 egg / female / day) than for those fed on GDM mycelium (0.73 egg / female / day).

Developmental times from egg to adult for *A. andersoni* female were slightly lower on pollen (140.33 h) than on GDM (142.92 h). Moreover, no differences were observed regarding developmental times of *A. andersoni* males, between pollen (100.5 h) and GDM mycelium (108.33 h). *A. andersoni* oviposition rate was higher on pollen (0.97 egg / female / day) than on GDM mycelium (0.57 egg / female / day)

Conclusions

The dynamics of *T. pyri* populations seemed to be related to the availability of pollen more than to GDM foliar symptoms. Laboratory studies showed that pollen affected positively development and reproduction of *T. pyri* confirming its role as alternative food. GDM mycelium affects positively the development and allows reproduction of *T. pyri.* Therefore, GDM can be considered as an alternative food for *T. pyri* according to Overmeer (1985, in Helle & Sabelis, 1985). *Amblyseius andersoni* populations clearly increased when GDM foliar symptoms were commonly recorded on leaves. GDM affected positively both development and reproduction of *A. andersoni* and thus it can be considered as an alternative food for this predator. In contrast to *T. pyri*, *A. andersoni* populations occurred at low levels in spring despite the abundance of pollen. However, laboratory studies showed the role of pollen as alternative food for *A. andersoni*. Additional studies should be addressed to determine how food source switch can affect predatory mite development as well as the role of alternative food presence in intra-guild relationships.

Two phytoseiid species co-occurred and persist in this vineyard in conditions of prey scarcity by feeding on alternative foods. Co-occurrence of two generalist predatory mites instead of a single one can apparently guarantee more chances of success for biological control of phytophagous mites. However, the role of *A. andersoni* in controlling tetranychid mites in vineyards in north-eastern Italy is considered to be lower than that of *T. pyri* (Duso, 1989; Duso & Vettorazzo, 1999). In any case, the management of alternative foods for phytoseiids remains a crucial point for IPM. It has been shown that the main component of windborne pollen in vineyards of north-eastern Italy is represented by taxa belonging to the Poaceae family. Field experiments showed that the amount of windborne pollen (mainly Poaceae) on grape canopy can be increased by reducing the frequency of grass mowing. Phytoseiid densities increased moderately following this agricultural practice (Girolami *et al*, 2000). The management of GDM for predatory mites is more complicated. *A. andersoni* population increases reported in the present study seemed to be promoted by late GDM infections which are considered not economically important. These *A. andersoni* late increases were sometimes associated to a *T. pyri* decline as reported in other studies (Camporese & Duso, 1996; Duso & Vettorazzo, 1999). It has been shown that in the interspecific competition between *A. andersoni* and *T. pyri* the former species is advantaged by its higher interspecific predation (Croft & Croft, 1996; Croft *et al.*, 1996). Therefore, the management of these two bio-control agents, where occurring in the same site, should consider the role of alternative foods.

References

Boller E. -F., Frey B., 1990 – Bluhende Rebberge in der Ostschwiez. I. Zur Bedeutung des Pollens für die Raubmilben. *Schwiez Zeitschrift für Obst- und Wienbau*, 122, 401-405.

Camporese P., Duso C., 1996 - Different colonization patterns of phytophagous and predatory mites (Acari: Tetranychidae, Phytoseiidae) on three grape varieties: A case study. *Experimental and Applied Acarololgy*, 20, 1-22.

Croft B. -A., Kim S. -S., Kim D. -I., 1996 - Intra- and interspecific predation on four life stage groups by the adult females of *Metaseiulus occidentalis, Typhlodromus pyri, Neoseiulus fallacis* and *Amblyseius andersoni* (Acari: Phytoseiidae). *Experimental and Applied Acarology* 20, 435-444.

Croft B.-A., Croft M. -B., 1996 - Intra- and interspecific predation among adult female phytoseiid mites (Acari: Phytoseiidae): Effects on survival and reproduction. *Environmental Entomology* 25, 853-858.

Duso C., 1989 - Role of *Amblyseius aberrans* (Oud.), *Typhlodromus pyri* Scheuten and *Amblyseius andersoni* (Chant) (Acari, Phytoseiidae) in vineyards. I. The effects of single or mixed phytoseiid population releases on spider mite densities (Acari, Tetranychidae). - *Journal of Applied Entomology,* 107, 474-492

Duso C., Camporese P., 1991 – Developmental times and ovoposition rates of predatory mites *Typhlodormus pyri* Scheuten and *Amblyseius andersoni* (Chant) (Acari: Phytoseiidae) reared on different foods. *Experimental and Applied Acarology*, 13, 117-128.

Duso C., de Lillo E., 1996 – Grape. *In Lindquist, E., Sabelis, M.W., Bruin, J. Eriophyoid Mites. Their Biology, Natural Enemies and Control, World Crop Pests*, Elsevier Science B.V., Amsterdam, 571-582.

Duso C., Malagnini V., Paganelli A., 1997 – Indagini preliminari sul rapporto tra polline e *Kampimodromus aberrans* (Acari: Phytoseiidae) su Vitis vinifera L. *Allionia* , 35, 229-239.

Duso C., Malagnini V., Paganelli A., Aldegheri L., Bottin M., 2002 – Phytoseiid mites –pollen relationships: observation in a vineyard and the sourronding vegetation. *In: Bernini F., Nannelli R., Nuzzacci G., de Lillo E. Acarid Phylogeny and Evolution,* 373-387.

Duso C., Pozzebon A., Capuzzo C., Bisol P. -M., Otto S., 2003 - Grape Downy Mildew Spread and Mite Seasonal Abundance in Vineyards: Evidence for the Predatory Mites *Amblyseius andersoni* and *Typhlodromus pyri*. *Biological Control,* 27, 229 - 241.

Duso C., Vettorazzo E., 1999 - Mite population dynamics on different grape varieties with or without phytoseiids released (Acari: Phytoseiidae). *Experimental and Applied Acarololgy*, 23, 741-763.

Eichhorn K. -W., Hoos D., 1990 – Investigation in population dynamics of *Typhlodromus pyri* in vineyards of Palatina, F.R. Germany. *IOBC Bulletin*, 1990/XIII/7, 120-123.

Engel R., Ohnesorge B., 1994 – Die Rolle von Ersatznahrung und Mikroklima im System Typhlodromus pyri Scheuten (Acari, Phytoseiidae) – Panonychus ulmi Koch (Acari, tetranychidae) auf Weinreben 1. Untersuschungen im Labor. *Journal of Applied Entomology*, 118,129-150.

Girolami V., Malagnini V., Di Bernardo A. and Duso C., 2000 - Phytoseiids – pollen relationships in Italian vineyards. *XXI International Congress of Entomology (Abstracts),* 35 p.

Helle W , Sabelis M. -W., 1985 - *Spider mites: their biology, natural enemies and control*. Elsevier, Amsterdam.

McMurtry J. -A., Croft B. -A. , 1997 - Life-styles of phytoseiid mites and their roles in biological control. *Annual Review of Entomolology* 42, 291-321.

Nyrop J.-P., English-Loeb G.-M., Roda A. -L., 1998 - Conservation biological control of spider mites in perennial cropping system. *In : Barbosa P. Conservation of natural enemies of pest*. Academic Press, New York , 307-333.

Overmeer W. - P. -J., 1985 - Alternative prey and other food resources. *In : Helle W , Sabelis M.-W. (eds) 1985 Spider mites: their biology, natural enemies and control*. Elsevier, Amsterdam, 131-137.

Schausberger P., 1992 – Vergleichende Untersuchungen über den Einfluss unterschiedlicher Nahrung auf die Praimaginalentwichlung und die Reproduktion von *Amblyseius aberrans* Oud. Und *Amblyseius finlandicus* Oud. (Acarina: Phytoseiidae). *Journal of Applied Entomology*, 113, 476-486.

Schruft G.-A., 1985 - Grape. *In : Helle W., Sabelis M. -W. Spider mites. Their biology, natural enemies and control*, Elsevier, Amsterdam, 359-366.

Wiedmer U., Boller E.-F., 1990 – Bluhende Rebberge in der Ostschweiz: 2 Zum Polenangebot auf den Rebenblattern. *Schwiez Zeitschrift für Obst- und Weinbau*, 126, 426-431.