*Zoosymposia* 6: 111–117 (2011)
www.mapress.com/zoosymposia/

ISSN 1178-9905 (print edition)
**ZOOSYMPOSIA**
ISSN 1178-9913 (online edition)

# Seasonal population development of spider mites (Acari: Tetranychidae) and their predators in sprayed and unsprayed apple orchards in Van, Turkey*

İSMAIL KASAP
*Çanakkale Onsekiz Mart University, Agricultural Faculty, Department of Plant Protection, 17020 Çanakkale / Turkey; E-mails: ikasap@hotmail.com; ikasap@comu.edu.tr*

* *In*: Moraes, G.J. de & Proctor, H. (eds) Acarology XIII: Proceedings of the International Congress. Zoosymposia, 6, 1–304.

## Abstract

The aim of this study was to determine the seasonal population dynamics of spider mites [*Panonychus ulmi* (Koch), *Amphitetranychus viennensis* (Zacher), *Bryobia rubrioculus* (Scheuten)] and their natural enemies [*Kampimodromus aberrans* (Oudemans), Acari, Phytoseiidae; *Zetzellia mali* (Ewing), Acari, Stigmaeidae; and *Stethorus punctillum* Weise, Coleoptera, Coccinellidae] on Golden Delicious and Starking Delicious apple cultivars in three apple orchards of Van, Turkey, during 2002–2003. Surveys were carried out weekly from May to November in sprayed and unsprayed apple orchards. The results of study indicated that the population densities of spider mites began to increase generally in early May, reached the maximum level from mid June to late August and persisted until late September in both years. During 2002 the dominant species on both apple cultivars was *P. ulmi*, whereas in 2003 it was *A. viennensis*. In this two-year period, the population densities of *P. ulmi* and *A. viennensis* reached the maximum level of 318.1 and 427.2 mites per leaf, respectively, in sprayed orchards. In unsprayed orchard, spider mites remained at very low levels because of the presence of *K. aberrans* which was the only predator of spider mites. On the other hand, in sprayed orchards, although *S. punctillum* and *Z. mali* were the most abundant predatory species on spider mites, they could not control them in either apple cultivar and years.

**Key words:** Biological control, coccinellids, population dynamics, spider mites, predatory mites

## Introduction

Apple is one of the most common crops in the world; worldwide, apple production reaches about 58 billion tons at each year (Gül & Erkan, 2001). About 2,410 thousand tons of apple are produced at each year in Turkey, where the growing areas are mainly concentrated in the regions of Bursa-Yalova-Çanakkale, Amasya-Tokat, Isparta–Burdur-Antalya and Niğde-Nevşehir-Kayseri (Gül & Erkan, 2001). Apple is a major fruit crop in the Van region of Turkey, where approximately 4,568 tons of apple are produced in 1,596 ha at each year, accounting for 0.2% of Turkey's total apple production (Anonymous, 2005).

During the growing season, various arthropod species and diseases cause economic losses to apple, particularly aphids (especially *Aphis pomi* De Geer, Homoptera, Aphididae), mites [*Panonychus ulmi* (Koch) and *Amphitetranychus viennensis* (Zacher), Acari, Tetranychidae], moths (*Yponomeuta malinellus* Zeller and *Cydia pomonella* Linnaeus, Lepidoptera, Yponomeutidae, Tortricidae) and apple scab [*Venturia inaequalis* (Cooke)]. These have become serious pests and disease during the last years (Erol & Yaşar, 1996; Yardım *et al*., 2002). Control of these pests and disease relies mainly on pesticide spraying programs. The disruptive effects of pesticides, especially due to development of resistance by pests, have led to greater reliance on natural enemies for their control in the Van region (Erol & Yaşar, 1996; Atlıhan *et al*., 2002; Yardım *et al*., 2002). Yet, suppression of the natural enemies by pesticides has been causing spider mites outbreaks. The effects of predatory species on the species composition and seasonal abundance of spider mites have not been previously investigated in commercial apple orchards in Van.

*Accepted by G. J. de Moraes: 30 Oct. 2011; Published: 20 Dec. 2011*

In recent years, population densities and economical importance of spider mites has greatly increased in Van (Kasap & Çobanoğlu, 2007). However, population dynamics of these mites and their natural enemies in apple orchards has been poorly investigated. The present study was primarily designed to provide data on the population dynamics of those mites and their natural enemies in Van Lake Basin of Turkey.

## Materials and Methods

Experiments were conducted in three apple orchards in Van (Edremit I; 38° 25' N; 43° 14' E; Edremit II; 38° 25' N; 43° 16' E and Şamranaltı; 38° 29' N; 43° 21' E) from 2002 to 2003. Two apple cultivars, Golden Delicious and Starking Delicious, were planted in a mosaic in these orchards, and the age of trees ranged between 15–20 years. These are the most common apple varieties in Turkey (Gül & Erkan, 2001). The apple trees in Edremit I orchard were sprayed with fluvalinate (50 mL per 100 L) on 4 and 29 July 2002 and on 13 July 2003, to control *C. pomonella* (L.) and *A. pomi*. The apple trees in Şamranaltı were sprayed with fluvalinate (50 mL per 100 L) on 4 and 29 July 2002 and with phosolone (200 mL per 100 L) to control *C. pomonella* on 5 July 2002 and with fluvalinate (50 mL per 100 L) to control *C. pomonella* and *A. pomi* on 26 July 2003. In Edremit II no chemical treatment has been applied since the orchard was established.

The population densities of spider mites and their predators were monitored weekly from 30 May to 31 October in 2002 and from 1 May to 8 October in 2003. For the experiments, seven trees were marked for each apple cultivar in three orchards. Ten leaves were collected randomly from the periphery (1.2–2.3 m high) of the marked trees. The leaves were brought to the lab in plastic containers and stored at 4ºC in the refrigerator. Mites on the leaves were counted under a stereomicroscope (magnification 40 x) within three days of the collection. A beating technique (Steiner, 1962) was employed for the sampling of predaceous insects; for this, a branch from each of five orchard regions (east, west, north, south and central) was beaten three times and samples were collected in a jar.

## Results and Discussion

Seasonal fluctuations of spider mites and their predators varied in sprayed and unsprayed orchards throughout the study period (Figs.1, 2). In Edremit I (a sprayed orchard), at the beginning of 2002 season, *Bryobia rubrioculus* (Scheuten) population started to increase in early May and the population density reached the maximum level with 27.1 mites per leaf in early July on Starking Delicious, declining afterwards. In early August, *A. viennensis* started to increase and peaked in mid August (413.3 mites per leaf), declining later with a concurrent increase in the density of the predatory coccinellid beetle *Stethorus punctillum* Weise. In early October, *P. ulmi* began to show up, but its population remained very low until early October. In the other sprayed orchard (Şamranaltı), *P. ulmi* population started to increase in early May and its population peaked on June 19 2002 (318.1 mites per leaf), then decreasing gradually. This decrease seemed to be mainly due to predatory effect of *S. punctillum*. In the same periods, *A. viennesis* population started to increase, but the population stayed at low levels, possibly because of the predatory effect of *S. punctillum* and *Zetzellia mali* (Ewing) throughout the season. In both experimental areas, the predatory mites *Z. mali* and *K. aberrans* populations were observed, especially *Z. mali*, which reached a density of 12.5 mites per leaf in Şamranaltı (Fig. 1).

In 2003, *A. viennesis* and *B. rubrioculus* populations started to increase in late May, but *B. rubrioculus* increased more quickly than *A. viennesis* in late June, reaching a density of 18.6 mites per leaf on Starking Delicious in Edremit I (Fig. 1). Then the population of these mites decreased grad-

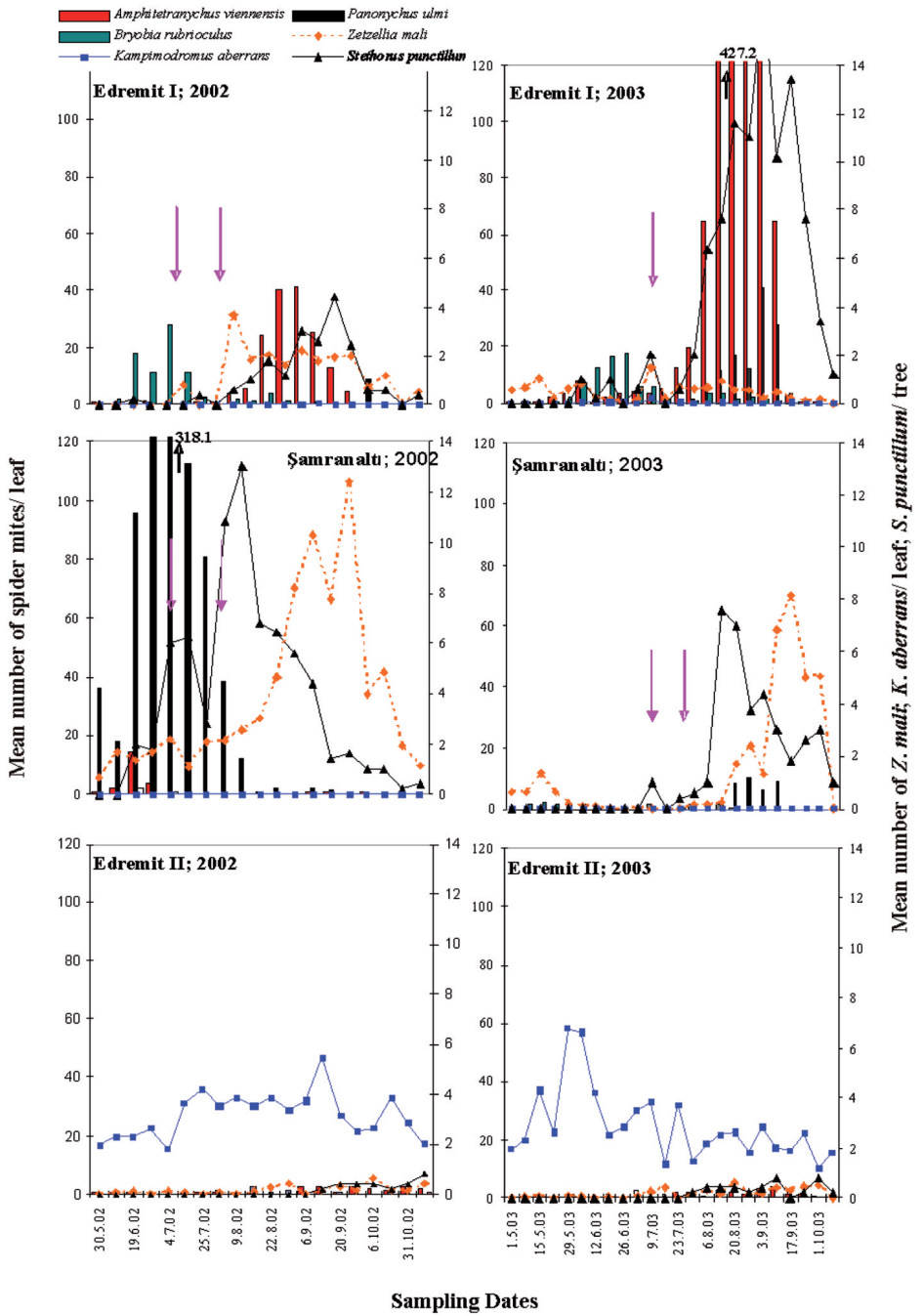


**FIGURE 1.** Seasonal populations of spider mites (*Amphitetranychus viennensis*, *Bryobia rubrioculus* and *Panonychus ulmi*; eggs + mobile stages) and their predators *Zetzellia mali* (mobile stages), *Kampimodromus aberrans* (egg + mobile stages) and *Stethorus punctillum* (egg + mobile stages) on Starking Delicious apple cultivar in 2002 and 2003 [arrows (↓), insecticide spray].

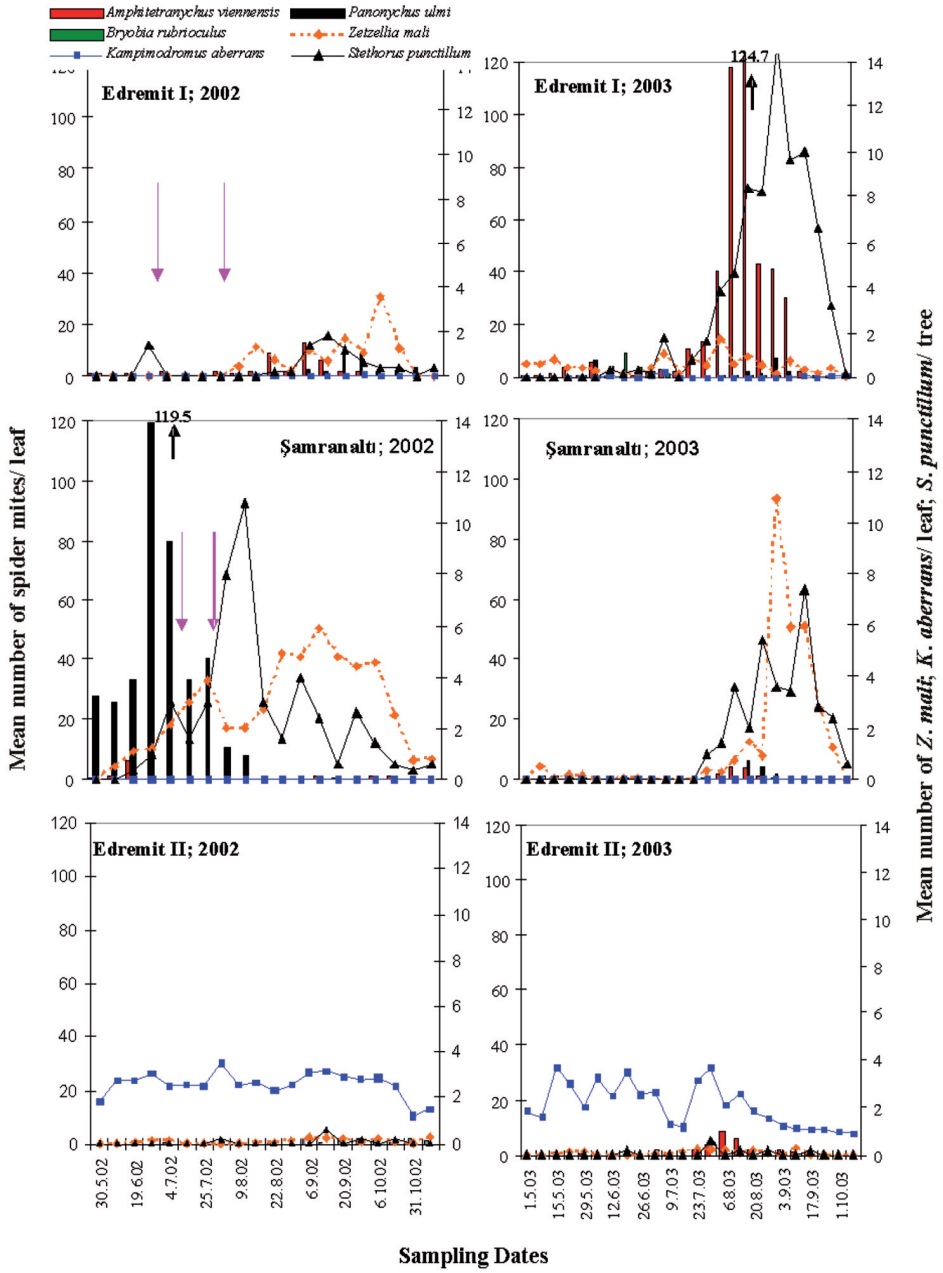


**FIGURE 2.** Seasonal populations of spider mites (*Amphitetranychus viennensis*, *Bryobia rubrioculus* and *Panonychus ulmi*; eggs + mobile stages) and their predators *Zetzellia mali* (mobile stages), *Kampimodromus aberrans* (egg + mobile stages) and *Stethorus punctillum* (egg + mobile stages) on Golden Delicious apple cultivar in 2002 and 2003 [arrows (↓), insecticide spray].

ually with the concurrent increase in the population of predators, especially *Z. mali* in Edremit I. In 2003, *A. viennesis* showed a very different trend from what was observed in 2002 on both apple cultivars in Edremit I. Its population started to increase in late July and the population density reached the maximum level, 427.2 and 124.7 mites per leaf in mid August on Starking and Golden Delicious cultivars, respectively (Figs. 1, 2). After this date, the population decreased gradually until mid September, with the increase in the population of *S. punctillum*. In the other experimental area (Şamranaltı), *A. viennesis* and *P. ulmi* reached lower levels in 2003 than in 2002 on both cultivars (Figs. 1, 2). *Amphitetranychus viennesis* and *P. ulmi* started to show up in the beginning of July and *P. ulmi* reached a peak in late August (9.8 mites per leaf). Later, *P. ulmi* decreased gradually until early September, also with the increasing populations of *Z. mali* and *S. punctillum*.

In the unsprayed apple orchard Edremit II, spider mite populations remained at low levels during the whole experiment periods, under the predatory effect of *K. aberrans*, whose population started to increase in early May, remaining at a density of 1.2–6.8 mites per leaf during the whole experiment on both apple cultivars in 2002 and 2003.

On Golden Delicious, spider mites and their predators showed a similar population development as observed on Starking Delicious in both years and experimental areas, but their populations were higher on Starking than on Golden Delicious (Figs. 1, 2).

This study strongly suggests that pesticide applications changed the population development and the pattern of dominance of spider mites in apple orchards. Also, pesticide application apparently resulted in an increase in spider mites populations such as *A. viennensis*, *P. ulmi* and *B. rubrioculus* in the two sprayed orchards. These results are in agreement with Amano & Chant (1990), Hardman *et al*. (1997), Van de Vrie (1985) and Yanar & Ecevit (2008). Furthermore, the population dynamics of predators appears to have changed with pesticide application. In the unsprayed orchard (Edremit II), the population density of *K. aberrans* was markedly higher than in the sprayed orchards and spider mites remained at very low levels. In sprayed orchards, that predator was not found. On the other hand, *Z. mali* and *S. punctillum* were common predator species and reached high population levels in sprayed orchards, but they were few in unsprayed orchards. In the sprayed orchards, *Z. mali* seemed to be the most common predatory mite on spider mites. This species has been reported to be tolerant of pesticides and to be the dominant predatory mite in sprayed apple orchards in Michigan, USA (Strickler *et al*., 1987). Villanueva & Harmsen (1998) stated that *Z. mali* was more abundant in pyrethroid sprayed plots in Ontario, Canada, than in plots unsprayed with these pesticides. It is likely that *Z. mali* has developed resistance to pyrethroids and could be competitive, especially with phytoseiid mites.

Eggs of *B. rubrioculus* began to hatch on apple tree trunks by mid May and population densities peaked from mid June to early July. Thereafter, its populations remained at low levels on both apple cultivars throughout the season. But, then in the remaining of the season, *P. ulmi* and *A. viennensis* were dominant species in the sprayed orchards. These mite populations peaked from mid June to late August and remained at high levels up to late September in both years and apple cultivars. But, in the unsprayed apple orchard densities of those mites remained very low on both apple cultivars throughout the season, apparently because of the predatory effect of *K. aberrans*. Yanar & Ecevit (2008) reported that the dominant phytophagous mites in sprayed orchards in Tokat, Turkey, were *A. viennensis* and *P. ulmi*, whereas in unsprayed orchards they were *Eotetranychus uncatus* Garman (Tetranychidae) and *Cenopalpus pulcher* (Canestrini & Fanzago) (Tenuipalpidae). Predatory mites appear able to control spider mites in pesticide-free orchard, but not in the sprayed orchards. İncekulak & Ecevit (2002) also reported that spider mites populations were suppressed by predators in unsprayed orchards in Amasya, Turkey.

Spider mites were more abundant on Starking than on Golden Delicious in each orchard. This might be due to the morphology of leaves of the former variety, which are hairier than those of Golden Delicious. Leaf hairs may hamper predators when searching for prey. However, Duso &

Pasini (2003) reported that *Amblyseius andersoni* Chant (Phytoseiidae) prefers the highly pubescent apple cultivars because of the availability of oviposition sites and protection from intraguild predation. In addition, Kreiter *et al*. (2002) reported that *K. aberrans* was the dominant phytoseiid on hairy leaves of *Celtis australis* L. (Ulmaceae).

The results of this study suggest that predatory phytoseiids may play a major role in the control of spider mites in the Van region of Turkey, if not killed by the use of pesticides. *Kampimodromus aberrans* is a generalist predatory mites that can survive on different food types (i.e., different plant pollen and rust mites) when prey is not present (Kasap, 2005, 2009). This likely allows them to maintain populations even at low densities of spider mites, and have a significant damping effect on early population growth of phytophagous mites on apple trees.

## Acknowledgements

This research was supported in part by the Scientific and Technical Research Council of Turkey (TUBİTAK/TOVAG-2966).

## References

Amano, H. & Chant, D.A. (1990) Species diversity and seasonal dynamics of Acari on abandoned apple trees in Southern Ontario, Canada. *Experimental and Applied Acarology*, 8, 71–96.

Anonymous (2005) The agricultural structure of Van. Turkish Ministry of Agriculture and Rural Affairs, The Agricultural Nation Directorship of Van, Available from http://www.vantarim.gov.tr (last viewed 20 Sept. 2004).

Atlıhan, R., Özgökçe, M.S. & Kaydan M.B. (2002) Some biological characteristics of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) on *Hyalopterus pruni* (Geoffer) (Homoptera: Aphididae). *Turkish Journal of Entomology*, 25, 223–230 [in Turkish with English abstract].

Duso, C. & Pasini, M. (2003) Distribution of the predatory mite *Amblyseius andersoni* Chant (Acari: Phytoseiidae) on different apple cultivars. *Journal of Pest Science*, 76, 33–40.

Erol, T. & Yaşar, B. (1996) Studies on the population fluctuations of *Aphis pomi* (De Geer) the pest on apple in Van Province. In: *Proceedings of the 3rd Turkish National Congress of Entomology*, Ankara, pp. 77–84 [in Turkish with English abstract].

Gül, M. & Erkan, O. (2001) Development in apple production on trade in the World and Turkey. *Journal of Faculty of Agricultura of Çukurova University*, 16, 1–10 [in Turkish with English abstract].

Hardman, I.M., Rogers, M.L., Gaul, S.O. & Bent, E.D. (1997) Insectary and initial testing in Canada of an organophosphate/ pyrethroid-resistant strain of the predator mite *Typhlodromus pyri* (Acari: Phytoseiidae) from New Zealand. *Environmental Entomology,* 26, 1424–1436.

İncekulak, R. & Ecevit, O. (2002) A research on determination of harmful and beneficial mite species in apple orchards in Amasya and their population densities. *Proceedings of the 5th Turkish National Congress of Biological Control*, Erzurum, pp. 297–314 [in Turkish with English abstract].

Kasap, İ. (2005) Life-history traits of the predaceous mite *Kampimodromus aberrans* (Oudemans) (Acari: Phytoseiidae) on four different types of food. *Biological Control*, 35, 40–45.

Kasap, İ. (2009) Influence of temperature on life table parameters of the predaceous mite *Euseius finlandicus* (Oudemans) (Acari: Phytoseiidae). *Turkish Journal of Agricultural and Forestry*, 33, 29–36.

Kasap, İ. & Çobanoğlu, S. (2007) Mite (Acari) fauna in apple orchards of around the Van Lake basin of Turkey. *Turkish Journal of Entomology*, 31, 97–109 [in Turkish with English abstract].

Kreiter, S., Tixier, M.-S., Croft, B.A., Auger, P. & Barret, D. (2002) Plants and leaf characteristics influencing the predaceous mite *Kampimodromus aberrans* (Acari: Phytoseiidae) in habitats surrounding vineyards. *Environmental Entomology*, 31, 648–660.

Steiner, H. (1962) Methoden zur Untersuchung der Populations dynamik in Obstanlagen. *Entomophaga*, 7, 207–214.

Strickler, K., Cushing, N., Whalon, M. & Croft, B.A. (1987) Mite (Acari) species composition in Michigan apple orchards. *Environmental Entomology*, 16, 30–36.

Van De Vrie, M. (1985) Apple. In: Helle, W. & Sabelis, M.W. (eds) *Spider mites: their biology, natural enemies and control*, Elsevier, Amsterdam, 1B, pp. 311–325.

Villanueva, R.T. & Hamsen, R. (1998) Studies on the role of the stigmaeid predator *Zetzellia mali* in the acarine

system of apple foliage. *Proceeding Entomologia Society Ontario*, 129, 149–155.
Yanar, D. & Ecevit, O. (2008) Species composition and seasonal occurrence of spider mites and their predators in sprayed and unsprayed apple orchards in Tokat, Turkey. *Phytoparasitica*, 36, 491–501.
Yardim, E., Atlıhan, R., Özgökçe, M.S. & Kaydan, M.B. (2002) *Integrated Pest Management optimization studies against to apple pests in the Van region*. Project final report, project no. 1838, The Scientific and Technical Research Council of Turkey, Ankara, Turkey [in Turkish with English abstract].