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Seasonal abundance of aphids and their natural enemies in walnut orchards in Lake Van Basin, Turkey

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Vangölü havzası ceviz bahçelerindeki yaprakbiti türleri ve doğal düşmanlarının populasyon değişimi

Özet: Vangölü havzasında 2005-2006 yıllarında yürütülen çalışmada, ceviz bahçelerindeki yaprakbiti türleri (*Chromaphis juglandicola* ve *Panaphis juglandis*) ile bunların parazitoit ve predatörlerinin populasyon yoğunlukları belirlenmiştir. Çalışma Adilcevaz ve Gevaş ilçelerinden seçilen iki bahçede yürütülmüştür.

Chromaphis juglandicola populasyonu çalışmanın her iki yılında ve her iki bahçede düşük düzeyde kalmış, *P. juglandis* populasyonu ise yaz başında oluşmaya başlamış ve yaz ortalarında en yüksek düzeyine ulaşarak ekonomik zarar eşik değerini geçmiştir. Daha sonra populasyonu düşmeye başlamış ve vejetasyon döneminin sonuna kadar düşük düzeyde seyretmiştir. Ceviz bahçelerinde yaprak bitlerinin avcıları olarak Coccinellidae (Coleoptera), Anthocoridae, Miridae (Hemiptera), Chrysopidae ve Hemerobidae (Neuroptera) familyalarına bağlı türler belirlenmiştir. Bunlar arasında *Adalia fasciatopunctata revelierei* (Mulsant) *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) ve *Orius* spp. en yaygın ve populasyonları en yüksek türler olarak belirlenmiştir. Her iki yaprak biti türünün parazitoidi olarak *Trioxys pallidus* Haliday saptanmış ve parazitoidin yaprakbitlerinin düşük yoğunluklarında etkili olduğu belirlenmiştir.

Anahtar sözcükler: Ceviz, *Chromaphis juglandicola, Panaphis juglandis,* parazitoit, predatör

Abstract: The seasonal abundance of the aphid species *Chromaphis juglandicola* and *Panaphis juglandis*) and their parasitoid and predators was investigated at two sites in Lake Van Basin in consecutive years (2005-2006). Populations of *C. juglandicola* remained low at both sites in both years but populations of *P. juglandis* began to develop in early summer and reached their highest level, which was considered above the economic threshold, in mid- summer. Populations then declined and fluctuated at a low level until the end of the season. Species belonging to Coccinellidae (Coleoptera), Anthocoridae, Miridae

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(Hemiptera), Chrysopidae and Hemerobidae (Neuroptera) were predators. *Adalia fasciatopunctata revelierei* (Mulsant), *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) and *Orius* spp. were the most abundant predators. *Trioxys pallidus* Haliday was the only species parasitizing both aphid species in walnut orchards and it appears to be effective in suppressing populations of the aphids to low levels.

Key words: Walnut, *Chromaphis juglandicola, Panaphis juglandis,* parasitoid, predator

Introduction

Turkey is among the world's leading walnut producers (Anonymous 2011a) and Lake Van Basin is one of the most important regions of Turkey with 431,145 trees and 9,549 tons of walnut production per year (Anonymous 2012). Two aphid species, the walnut aphid and the dusky-veined aphid, are common worldwide and are present in the Lake Van Basin. The walnut aphid, *Chromaphis juglandicola* (Kaltenbach) (Hemiptera: Aphididae) is an orchard pest originating from Asia (Davidson 1914; Nowierski 1979) and damages walnut trees all over Turkey. It is an autoecious, holocyclic species specific to the Persian walnut, *Juglans regia* L. and its cultivated forms and hybrids (Hougardy & Mills 2009). The economic threshold for the walnut aphid is considered to be 15 aphids per leaflet and higher densities early in the season reduce nut yield and quality and cause an increase in nuts with perforated shells (Sibbett et al. 1982; Anonymous 2011b), and an infestation in summer decreases nut quality (Anonymous 2011b). The dusky-veined aphid, *Panaphis juglandis* (Goeze) (Hemiptera: Calaphididae) also attacks walnut trees in Turkey, especially in the Lake Van Basin (Narmanlıoğlu & Güçlü 2008; Atlıhan et al. 2011). It is common throughout Europe (Heie 1992; Barbagallo et al. 1995; Nieto Nafria & Mier Durante 1998; Petrovič 1998), and Central Asia and the USA (Blackman & Eastop 2000). When a walnut tree is infested with this aphid, both the nut size and quality may decrease (Anonymous 2011b). If 10% to 15% of the leaflets are infested for 3 to 4 weeks before shell hardening, nut size is decreased. It has also been reported that the same level of infestation during late summer results in shriveled kernels at harvest time, and that treatment should be considered whenever an average of 10% of the subterminal leaflets have dusky-veined colonies of six or more feeding on their upper surface (Anonymous 2011b).

Ecologically sound management programs require a greater understanding of the interactions between pests and the beneficials that feed upon them. Therefore, knowledge about the seasonal population dynamics of pests and their natural enemies are the key to preparing control programs. Scientists and producers have been interested in aphid population dynamics for a long time because they cause serious damage in agricultural ecosystems (Mondor & Roitberg 2000). Parasitoids and predators as natural enemies are important factors in the population dynamics of aphids.

The aim of this study was to examine the seasonal occurrence and population dynamics of aphid species and their natural enemies in walnut ecosystems in Lake Van Basin, Turkey

Materials and methods

Sample sites

Two commercial walnut orchards with local genotypes of *Juglans regia* L. were sampled during 2005 and 2006. One of the orchards was located in Adilcevaz County and the other was in Gevaş County. Both orchards were untreated against pests and diesases during the study.

Aphid, mummy and predator densities

Samplings were carried out every week from late May to the end of October. Five trees were randomly selected in each orchard and the number of aphids (all instars) and aphid mummies were counted on the two subterminal leaflets of 20 leaves per tree (100 leaflets per orchard) on each sampling date. Leaf samples were randomly chosen around the tree in the lower and mid-canopy and brought to the laboratory. The upper surface of each leaflet was checked for dusky-veined aphids and the lower surface for walnut aphids. Besides the number of individuals per tree, the ratio of the leaflets infested with dusky-veined aphid colonies of six or more individuals was also determined. The percentage of parasitization was calculated as the ratio of the number of mummified aphids to the total number of aphids (Tomanovic et. al. 1996; Kavallieratos et. al. 2002a,b). Mummies included individuals from which no adult *T. pallidus* or hyperparasitoid had emerged, and individuals from which an adult *T. pallidus* or hyperparasitoid had emerged. Predators were sampled by beating four randomly chosen branches of trees with a stick over a $1m^2$ cloth screen. Five trees were sampled in each orchard, and on each tree, one branch was chosen for sampling on each of the four sides. The number of adults and immatures (larvae and nymphs) of the predators obtained was recorded.

Results and discussion

Since there is no established economic threshold (ET) for *P. juglandis* and *C. juglandicola* in Turkey to assess the importance of their population levels, the ET thresholds applied for both aphid species in California, US (Anonymous 2011b) were used. At the same time, it should be remembered that the ET is a complex value which depends on estimating and predicting several difficult parameters, and may differ from region to region. Populations of *P. juglandis* began to develop in Adilcevaz in the last week of May (May 27) and reached their highest level in July in 2005 (Figure 1). The ratio of the leaflets infested with dusky-veined aphid colonies of six or more individuals from the first week to third week of July was 14.4, 12.5, 13.8% respectively. The density (average 3.3, 3.6 and 3.2

individuals/leaf) was also highest in this period. The density declined in August and fluctuated at low levels until the end of the season. The aphid appeared for the first time in mid-May, 2006 and populations were high until mid-July (July 11), except for May 30 and June 6 (Figure 1). The populations declined and stayed at low levels from July 18 for the rest of the season (Figure 1). The aphid population in Gevaş began to increase from May 26, 2005 (Figure 2). Density of the aphid was generally low during the season, except for two weeks in July (July 14 and 21) in which the ratio of the leaflets infested with dusky-veined aphid colonies of six or more individuals reached 31.25 and 20%, respectively. There was an average of 10.79 and 4.58 aphids per leaflet in those two weeks, respectively. Individuals of *P. juglandis* were first recorded in Gevaş in mid-May (May 16) in 2006. Its population increased and reached its the highest level in the second week of July and declined afterwards (Figure 2). It was reported that treatment should be considered when 10% of the subterminal leaflets are infested with dusky-veined aphid colonies of six or more individuals (Anonymous 2011b). According to the results of the current study, *P. juglandis* densities reached the treatment threshold between the second half of June and the end of July in Lake Van Basin.

The density of *C. juglandicola* remained below 15 aphids per leaflet, which is considered the economic threshold in California, USA (Anonymous 2011b) at both sites and years. The seasonal pattern of aphid density differed between years, with the population density in 2005 higher than in 2006 at both sites, and aphid density highest in June and declining to a very low level until the first week of August, 2005 (Figure 1 and Figure 2).

Trioxys pallidus Haliday was the only species parasitizing both aphid species in walnut orchards. Parasitized individuals (mummies) of *C. juglandicola* were observed earlier than those of *P. juglandis* in both orchards and years (Figures 1 and 2), which means activity of the parasitoid started earlier on *C. juglandicola* than on *P. juglandis.*

It might be considered a reason for the low densities of *C. juglandicola*, even though the parasitization rate early in the season was low. Population peaks of mummies of both aphid species occurred late in the season (between late summer and fall), at which time the density of aphids was low in both sites and years. Similar to our results, the highest parasitization rates by *T. pallidus* on *C. juglandicola* were recorded late in the season (Nowierski 1979).

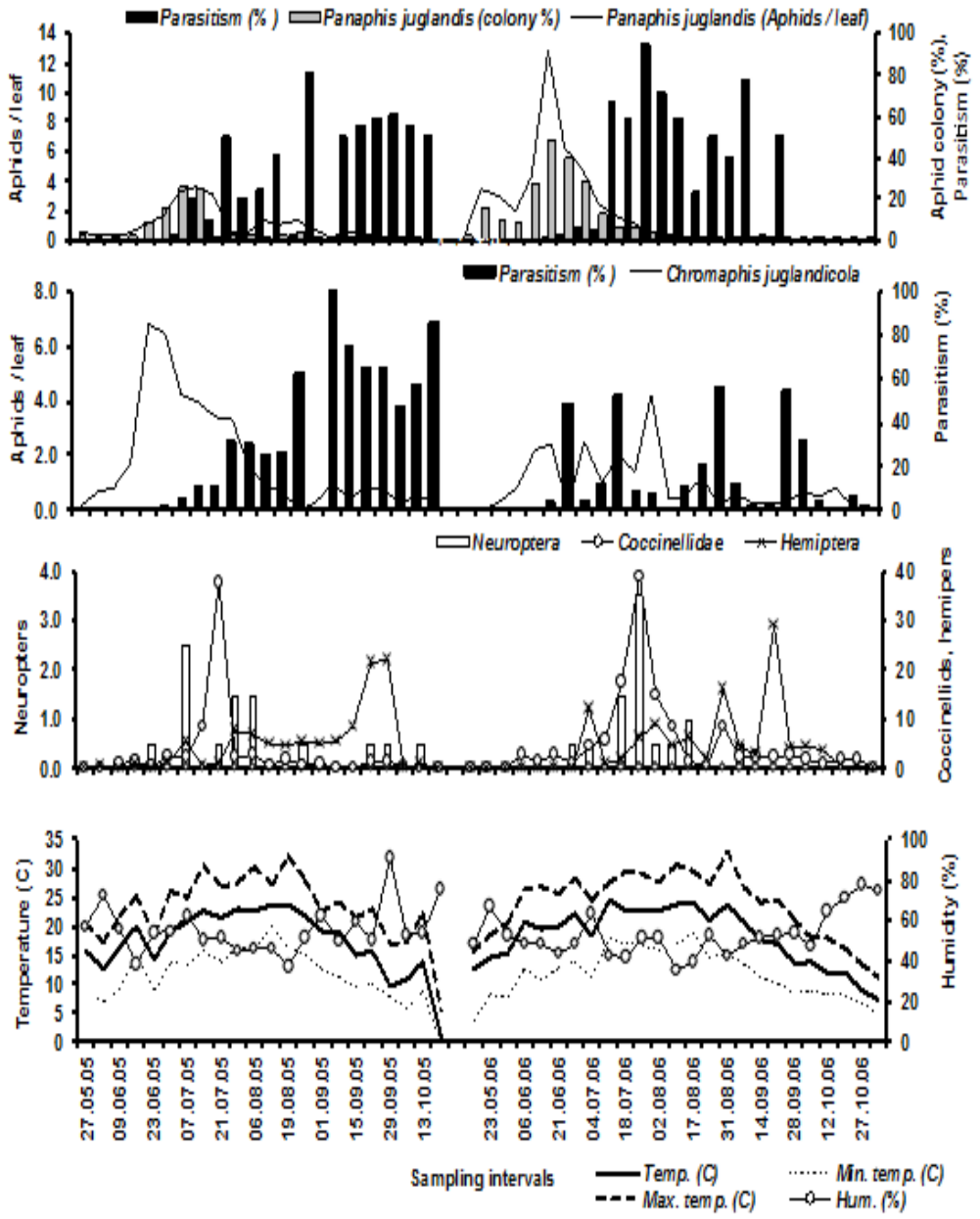

Figure 1. Seasonal abundance of *Panaphis juglandis* and *Chromaphis juglandicola* and their parasitoid and predators in a walnut orchard in Adilcevaz, Turkey in 2005 and 2006.

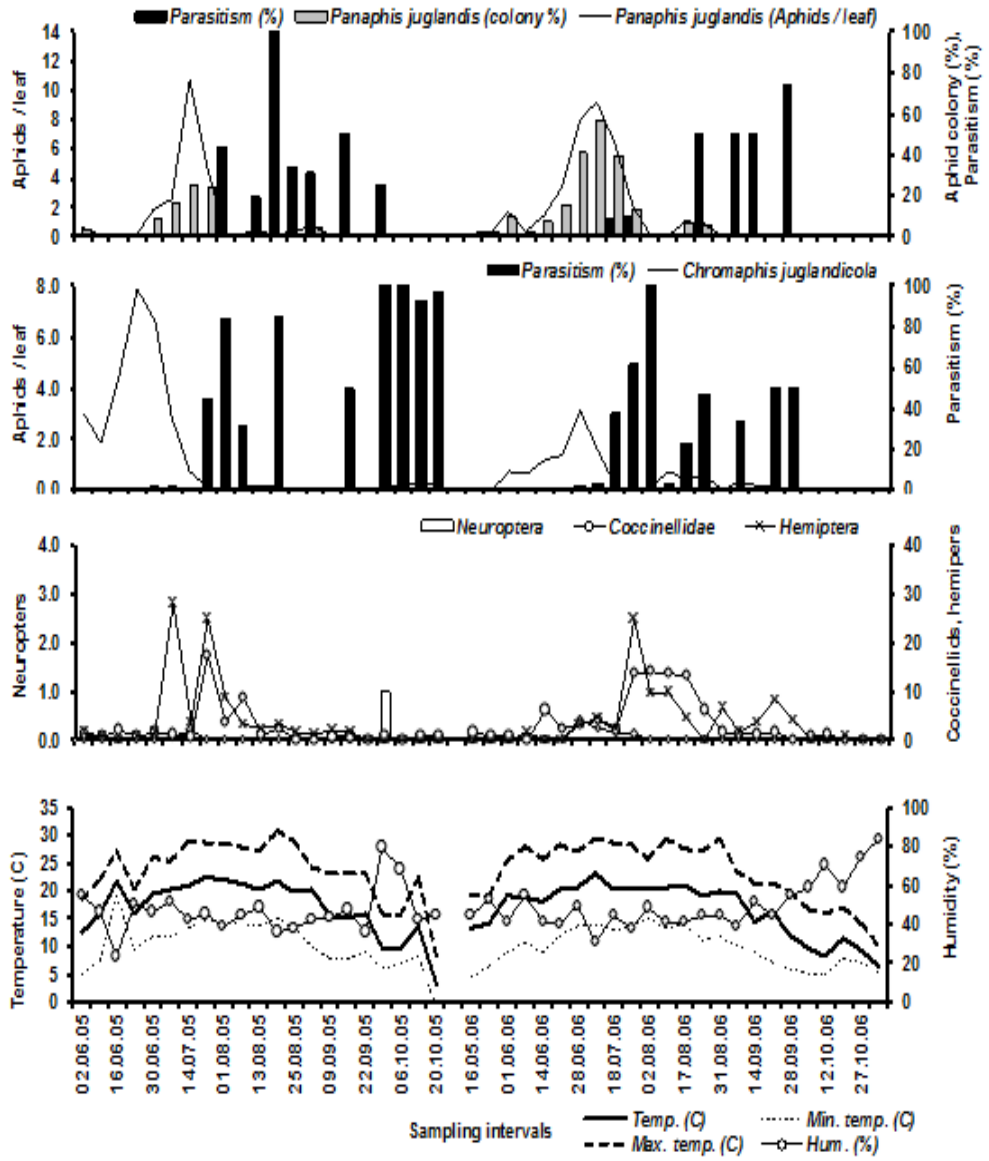

Figure 2. Seasonal abundance of *Panaphis juglandis* and *Chromaphis juglandicola* and their parasitoid and predators in a walnut orchard in Gevaş, Turkey in 2005 and 2006.

Parasitoid and predators of aphid species in walnut orchards in Lake Van Basin, Turkey are presented in Table 1.

Table 1. Parasitoid and predators of aphid species in walnut orchards in Lake Van Basin

Natural enemies	Location	
Predators	Adilcevaz	Gevaş
Hemiptera		
Anthocoridae		
Orius majusculus (Reuter)	+	+
Orius sp.	+	+
Anthocoris nemorum (Linnaeus)	+	+
Miridae		
*Phytocori*s sp.	-	+
Neuroptera		
Chrysopidae		
Chrysoperla carnea (Stephens)	+	+
Hemerobidae		
Hemerobius humulinus Linnaeus	+	-
Coleoptera		
Coccinellidae		
Adalia fasciatopunctata revelierei	+	+
Oenopia (Synharmonia) conglabata (L.)	+	+
Hippodomia (Adonia) variegata	+	+
Adalia bipunctata (L.)	+	+
Scymnus rubromaculatus (Goeze)	-	+
Scymnus interruptus (Goeze)	+	-
Scymnus araraticus Khnzorian	+	-
Scymnus pallidiformis Günther	+	-
Parasitoid		
Hymenoptera		
Aphidiidae		
Trioxys pallidus Haliday	+	+

Adalia fasciatopunctata revelierei (Mulsant) (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens 1836) (Neuroptera: Chrysopidae) and *Orius* spp. were the most abundant predator species. Eight coccinellid species were collected and 38% of adult coccinellids obtained were *A. fasciatopunctata revelierei*. Population peaks of coccinellid and neuropteran predators were between early summer and mid-summer at the two study sites for the two consecutive years. Peaks of hemipteran predators occurred in late summer in Adilcevaz and in mid-summer in Gevaş in both years (Figure 1 and Figure 2).

According to the results of the present study, the dusky-veined aphid, *P. juglandis* causes damage to walnuts, especially between early and mid-summer, during which time densities of the aphid reach the economic threshold and treatment is required, according to Anonymous (2011). After mid-summer, its density decreases. Besides the activity of the parasitoid and predators, higher maximum temperatures in mid-summer and the following weeks may also be an important factor in the decrease in densities of the aphid (Figure 1 and 2). The densities of the population walnut aphid, *C. juglandicola*, were below the economic threshold for treatment in both sites and years, according to Anonymous (2011).

In Lake Van Basin, pesticides are usually applied to suppress the codling moth (*Laspeyresia pomonella* L.) (Lep., Tortricidae) which is the major pest in walnut orchards (Atlıhan et al. 2011). This practice causes not only an extra cost and residue problems but also negatively impacts the natural biological control agents. Management programmes for controlling the codling moth should take *P. juglandis* and its natural enemies into consideration.

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