

Natural Enemies and Population Movement of the California Red Scale, *Aonidiella aurantii* Maskell (Homoptera: Diaspididae) with Efficiency of Parasitoid, *Aphytis melinus* (How.) (Hymenoptera: Aphelinidae) in Lemon Orchards

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ABSTRACT

This study was conducted to determine natural enemies, population movement of *Aonidiella aurantii* Maskell (Homoptera: Diaspididae) and efficiency of parasitoid, *Aphytis melinus* (How.) (Hymenoptera: Aphelinidae) in lemon orchards in Adana and Mersin provinces during 2004-2005. Sampling was made two times a month during March-September and once a month during October-February. Laboratory host *Aspidiotus nerii* Bouché (Homoptera: Diaspididae) was reared in climatized rooms on potatoes and squash in 25±1°C temperature and 50% humidity and 12/12 light and dark conditions. However, the rearing of parasitoid were carried out in the same conditions. *Aphytis melinus* was released as a dosage of 15 000 parasitoid ha⁻¹ in fifteen days interval totally 25.500 parasitoids when the male scales caught in traps baited with California red scale pheromone during March-October months. *Aonidiella aurantii* has three generations in spring, summer and autumn per year. The Release of parasitoid for each generation when the second stage and virgin females of the pest were abundant was found conformable. Parasitization rate was increased by releasing *A. melinus* according to the years. The highest parasitization rate was occurred on fruits, followed by leaves and shoots. The lowest parasitization rate was occurred on stem. Natural enemies were determined as *Comperiella* sp., *Chilocorus bipustulatus* L., *Stethorus* sp. *Rodolia cardinalis* (Muls.), *Cybocephalus* sp., *Scymnus* sp. (Coleoptera: Coccinellidae); *Conwentzia* sp. (Neuroptera: Coniopterygidae); *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae), *Paraseiulus soleiger* (Ribaga) (Acarina: Phytoseiidae).

Key words: Citrus, *Aonidiella aurantii*, *Aphytis melinus*, biological control, population movement, natural enemies.

INTRODUCTION

Citrus is an important product in Turkey's agriculture in terms of both the amount of production and the variety. 87% of the citrus are grown in the Mediterranean Region, 20% of which is exported (Anonymous, 2002). As is the case with all the others crops, among the factors that affect the productivity are also the problems with

diseases and pests, besides the growing problems like intercultivation, fertilization etc in citrus orchards. California red scale, *Aonidiella aurantii* Maskell (Homoptera: Diaspididae), is the main pest in the Eastern Mediterranean region in citrus growing. They cause damage by sucking on the stem and the thick branches. They populate on the fresh shoots, leaves and fruits and cause drying of the trees beginning from the shoots backwards and can lead to the death of the tree. Especially, the damage on the fruit is important as it directly affects the market price of the product. Except the white oils-which are advised in the technical instructions- many unadvised insecticides are used against the pest. With these applications the costs increases, human health is endangered and the environment is polluted as the recycling requires ages. There should be some other control methods as an alternative to chemical control among which biological control comes first. There are many natural enemies of the red scale in nature. These natural enemies are effective as the natural balance is maintained. However, for the balance- which rapidly spoils due to various reasons-to be mended, there is a need for supporting releases. *Aphytis melinus* (How.) (Hymenoptera: Aphelinidae), which is one of the natural enemies of the pest, is an effective and common parasitoid. The mass production of this parasitoid should be carried out to determine its effectiveness on the pest. This study was undertaken to determine population movement and natural enemies of California red scale and the effectiveness of *A. melinus* in the lemon orchards in Adana and Mersin provinces in 2004 and 2005.

MATERIALS AND METHODS

Laboratory host *Aspidiotus nerii* Bouché (Homoptera: Diaspididae) was reared in climatic rooms on potatoes and squash in $25\pm 1^\circ\text{C}$ temperature and 50% humidity and 12/12 light and dark conditions (De Bach & Fisher, 1956; Zhao, 1990). The production of parasitoid *A. melinus* was reared in the same climate rooms and in the production cages on the potatoes and squash intensively contaminated with second stage larvae and virgin females of *A. nerii*. Parasitoid was obtained by taking the California red scale, *A. aurantii* gathered from their natural habitat to culture.

The experiment was carried out in an orchard with 500 grapefruit tree in Kozan/ Adana and in Erdemli/Mersin with 10.000 lemon tree which was detected to be contaminated with the pest. The samplings were taken once a month from November to March and every fortnight from April to October. Besides, the population movement of California red scale and its parasitoid were conducted by taking samples from control plots in both orchards. The alive and parasitized individuals in 1 cm^2 surface on the four sides of trunk of citrus tree selected in sampling, in the 10 cm^2 surface in the four fresh shoots- each approximately 20 cm- on the four sides of the tree, in the 4 cm^2 on the 20 leaves from the four sides and the centre of the tree, and in the 4 cm^2

of the 5 fruits in the four sides and centre of the tree in the fruit period were counted and recorded according to their biological stage (Karaca & Uygun, 1992). During the sampling period, predators were determined by a visual sampling method. For the release of the *Aphytis melinus*, pheromone traps were hanged to the lemon plot on 24.03.2004 and 04.04.2005 in Kozan/Adana, on 09.03.2004 and 25.03.2005 in Erdemli/Mersin to determine the male flights of the red scale. The first parasitoid release was performed in March –when the numbers of the male in trap are the highest–on 31.03.2004 and 25.04.2005 and the releases were repeated every fortnight till the second half of October. For each orchard totally 25.500 *Aphytis melinus* were released which corresponds to 15000 parasitoids per ha (Grafton-Cardwell & Stewart-Leslie, 1998).

RESULTS AND DISCUSSION

In the lemon orchard of Kozan/Adana, besides the first adult was seen on the stem and shoot on 24.03.2004, virgin females and second stage larvae were also recorded, and reached the highest level on 03.08.2004, continued to appear at various levels till November (Fig. 1). The red scale settling on the shoots was being parasitized at a very low level. From July onwards, very low amount of parasitoids were seen. All the stages of the pest on the leaves were recorded at varying levels throughout the year, which reached to a peak level in August. The parasitization with respect to pest population was seen throughout the year and reached its highest level in September. The parasitization on the leaves was found to be higher than that of the shoots. On the fruit virgin females, first and second stage larvae were seen which reached to the top level in August. The parasitization was seen in from July to August and at the end of August and beginning of September, reached to the peak level and reduced the population of the red scale (Fig. 1). In their studies Luck & Podoler (1985), Yu (1986), Murdoch *et al.* (1989), Hare *et al.* (1990), Yu *et al.* (1990) similarly reported that parasitoids prefer the red scale on fruit and leaves to that of the shoots and branches. Gregory (1985) also pointed out that parasitoid spent most of its search time the 0.5 m around the tree and that it preferred the red scale on fruit and the leaves to that of the shoots and branches (Fig. 2). Similar results were obtained from the lemon orchard in Kozan/Adana in 2004 (Fig. 2).

In the lemon orchard of Kozan/Adana, the first virgin females and second stage larvae were found on stem and shoot on 21.03.2005 (Fig. 3). On the stem the population reached its highest level from June to July, and in August on the stem and shoot, respectively and appeared at a varying amount till September. Parasitized individuals were seen at a low amount on the stem and shoot from August to September.

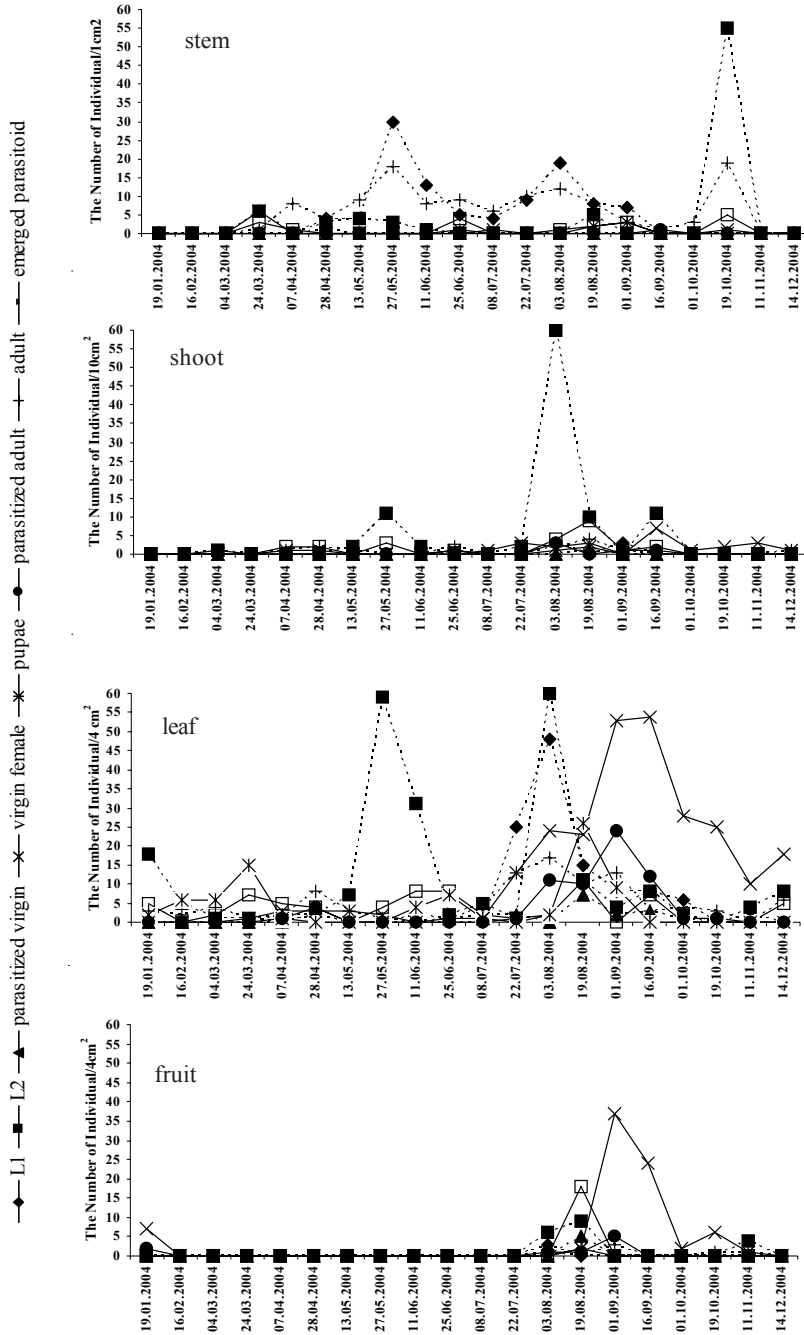


Fig. 1. Population movement of *A. aurantii* in released plot in lemon orchards in Kozan/Adana in 2004.

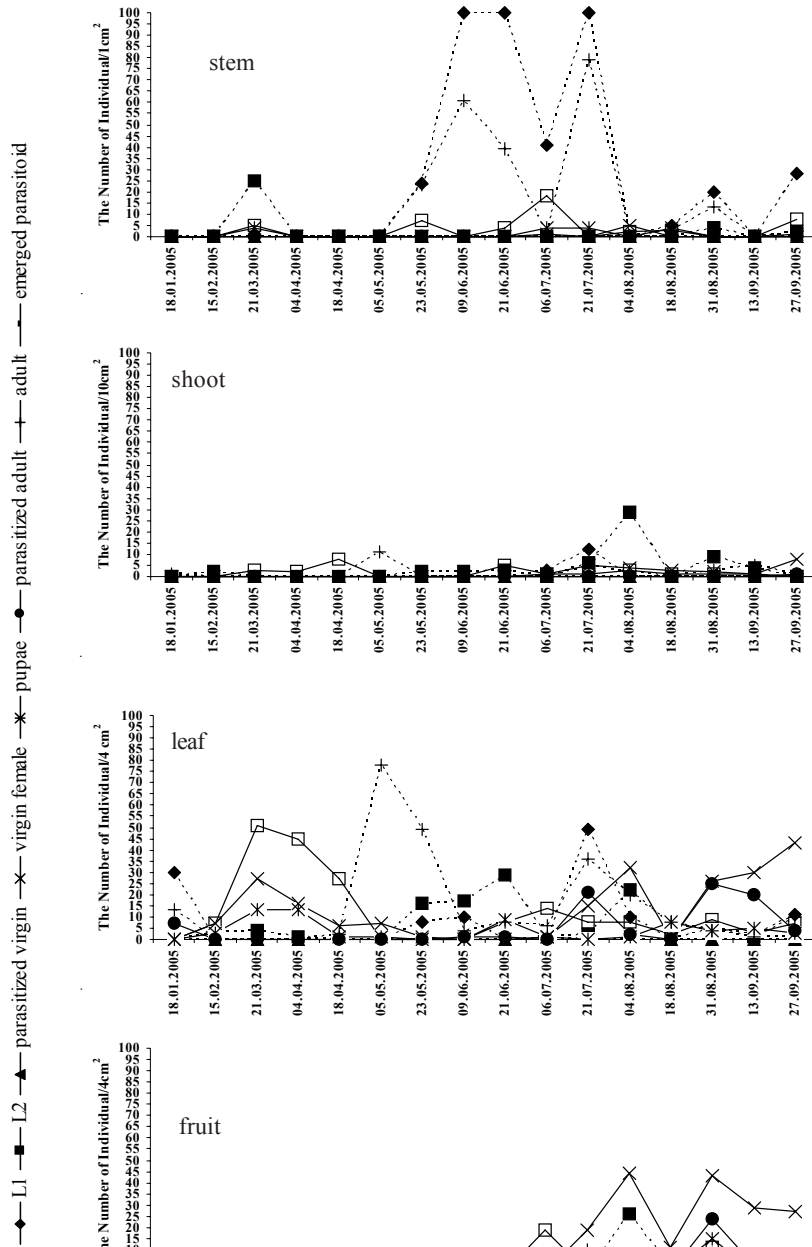


Fig. 2. Population movement of *A. aurantii* in control plot in lemon orchards in Kozan/Adana in 2004.

All the stages of the pest were seen on the leaves at varying amounts throughout the year and the parasitisation with respect to the population of the pest was detected all around the year. The virgin females on the fruit reached to their peak level from July to August and the second stage larvae reached to the top level in August (Fig. 3). On the fruit, the contamination was low but the parasitisation was high.

Besides parasitisation, the adult parasitoids were noticed to be sucking on the body liquids of the first stage active red scale and thus decrease the pest population (Anonymous, 2004). On the leaves and fruits the parasitisation was found to be higher than the stem and the shoots (Luck & Podoler, 1985; Murdoch et al., 1989; Hare et al, 1990). The results obtained correspond with the previous year.

In the lemon orchard of Kozan/Adana, similar results were obtained in the control plot in 2005 (Fig. 4). However, the virgin females and second stage larvae were found on the shoots in July and on the stem from August to September. The pest population on the leaves and the fruits were similar those of the previous year. On the leaves, the first and second stage larvae, and virgin females reached their highest level in May, June and July, respectively. In addition to the adult and virgin females, second stage larvae were seen from July to September on the fruit. Parasitisation was also at the highest level in these periods (Fig. 4).

In the lemon orchard of Erdemli/Mersin, the first adult of red scale and first and second stage larvae were seen on stem in 12.07.2004 (Fig. 5). The various stages of red scale on the stem and shoot were detected at very low amounts throughout the year. The virgin female reached its highest level on 26.10.2004. Parasitoids were seen on the stem in August, on the shoots in May-November. All the stages of the pests were detected on the leaves throughout the year and parasitisation due to pest population was noticed. Virgin females are seen in March-December and reached to its highest level in the last week of October. On the fruit, the second stage larvae of the red scale were seen from June to December, which reached to its highest level in August. In the same period, parasitized adults and virgin females were seen. Pest population was found to be low in the lemon plot in Mersin according to the in Adana. Due to the decrease in the pest population the parasitisation was also found to be low. The highest parasitisation was seen on the fruit, followed by leaves, shoots and the stem, respectively (Fig. 5). Besides parasitisation, it was pointed out that the adult parasitoids were sucking on the body liquid of the first stage active larvae of the red scale and thus caused a decrease in the population of the pest (Anonymous, 2004).

In the lemon control plot of Mersin/Erdemli, similar results were obtained (Fig. 6). On the stem and shoot, the parasitized individuals were seen in low ratios in July-August. While the parasitized individuals were seen on the leaves at varying amounts throughout the year, they were found on the fruit from July to December.

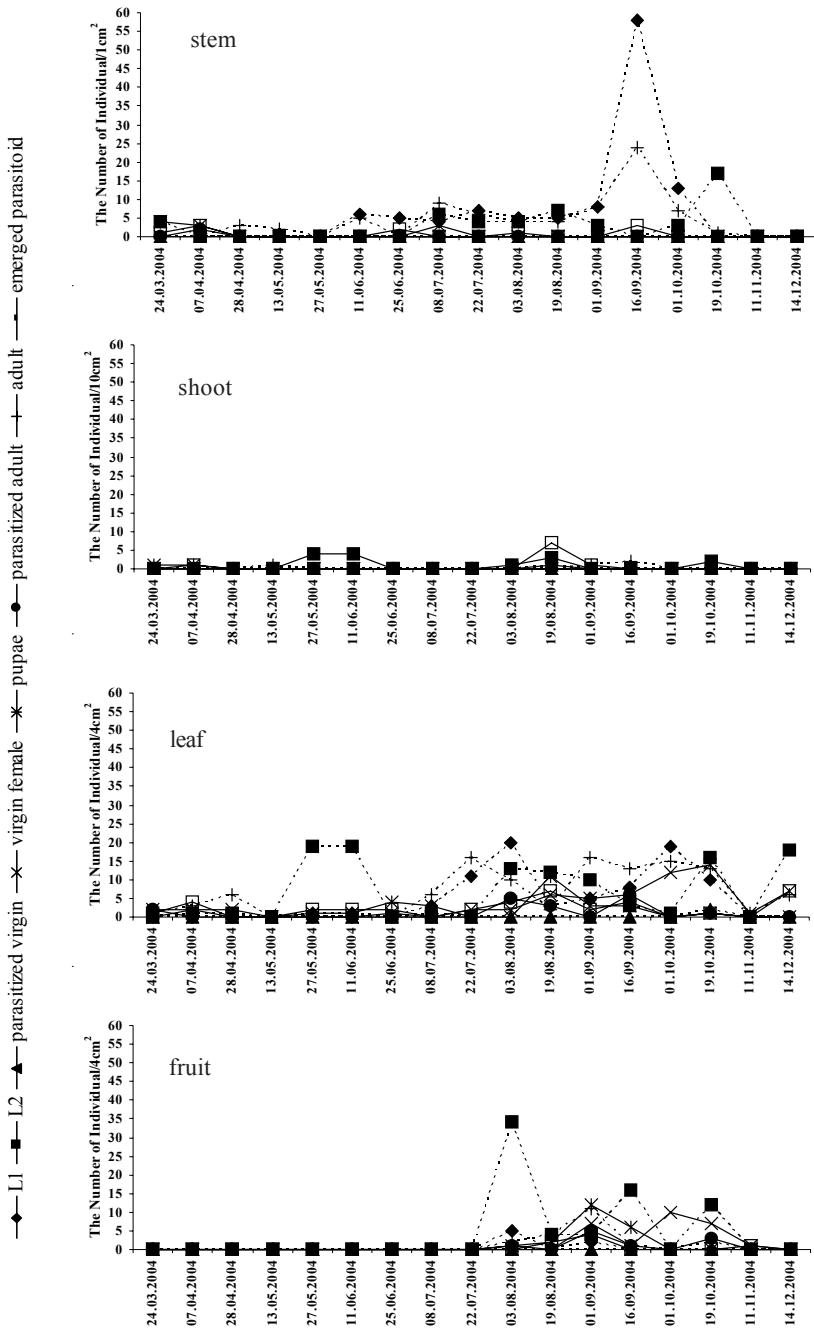


Fig. 3. Population movement of *A. aurantii* in released plot in lemon orchards in Kozan/Adana in 2005.

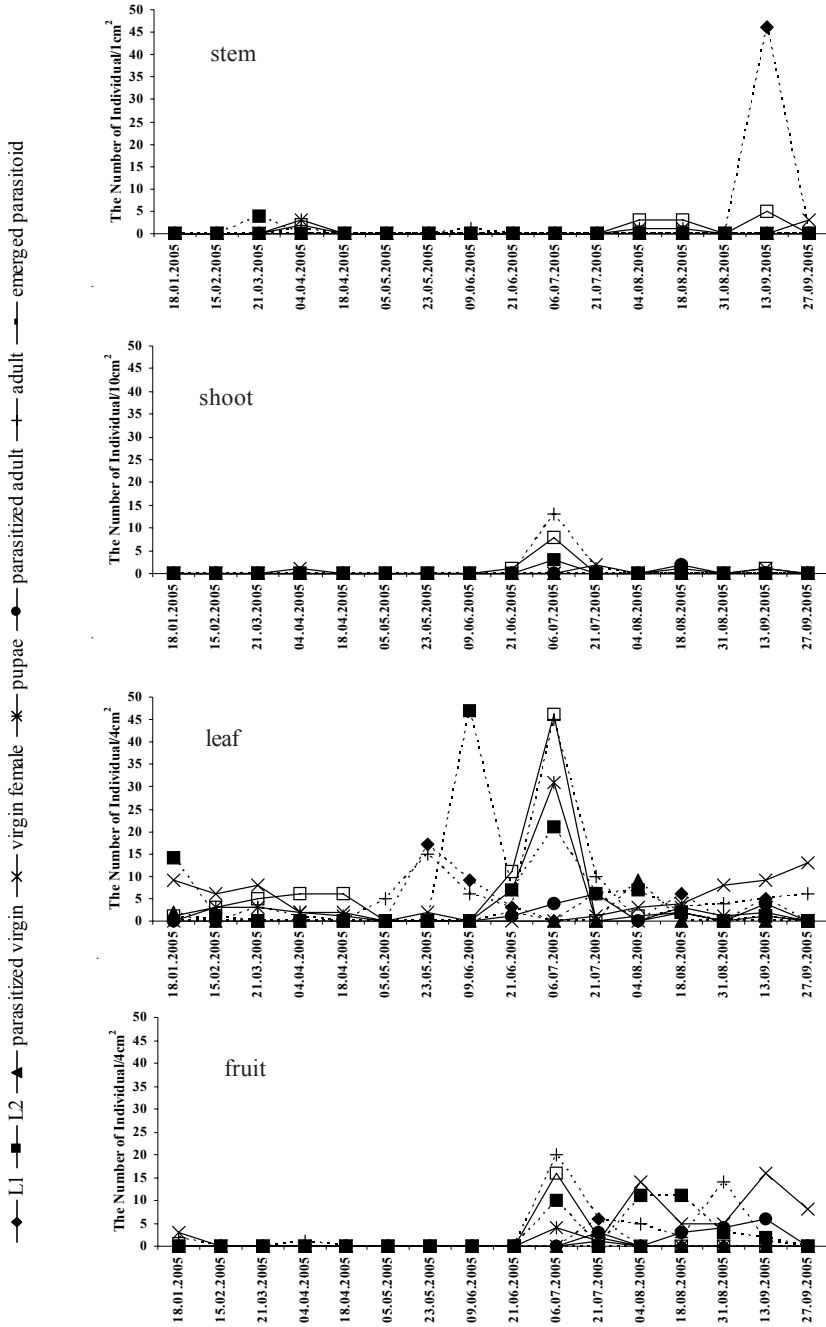


Fig. 4. Population movement of *A. aurantii* in control plot in lemon orchards in Kozan/Adana in 2005.

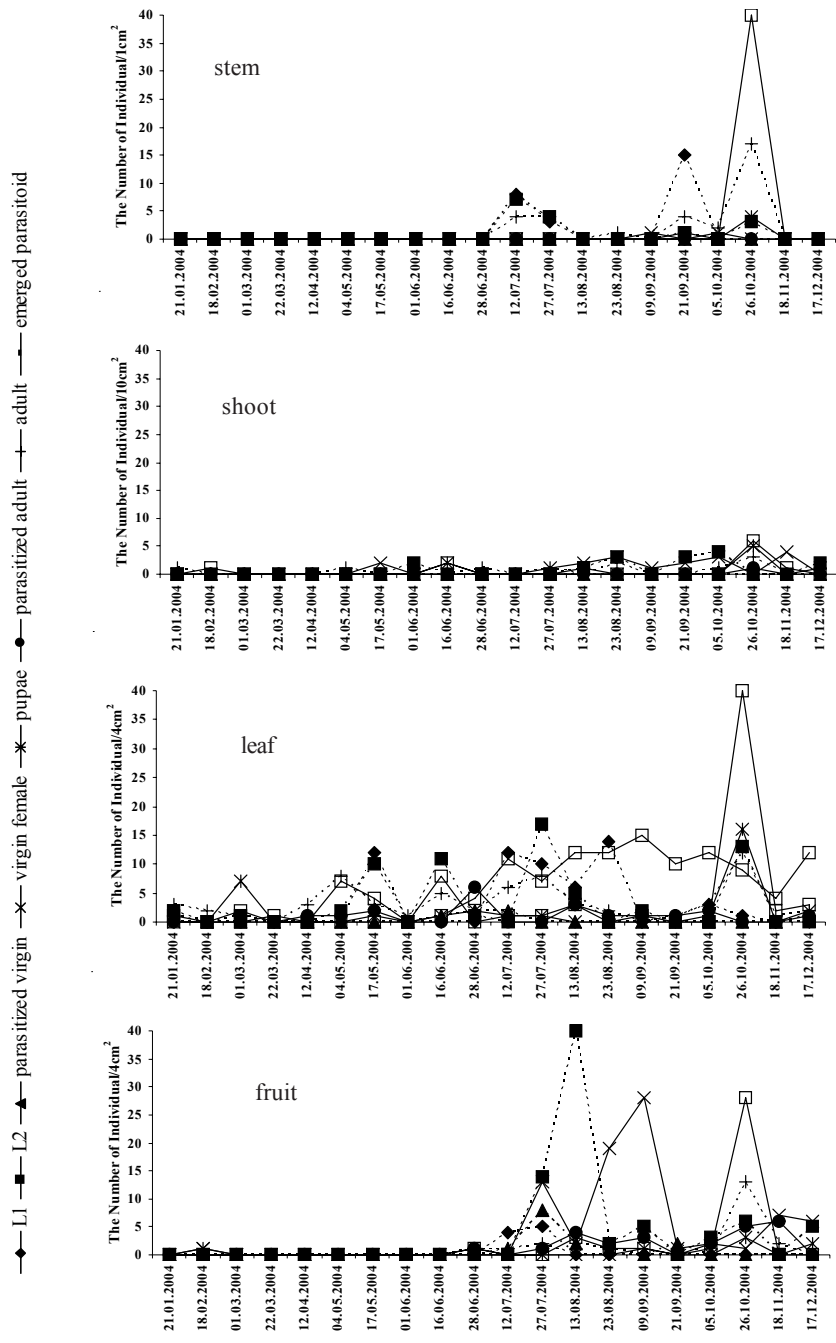


Fig. 5. Population movement of *A. aurantii* in released plot in lemon orchards in Erdemli/Mersin in 2004.

In the lemon orchard of Erdemli/Mersin, the pest population in 2005 was found to be lower than that of the previous year (Fig. 7). On the stem, virgin females were found in July-September, which reached its highest level on 16.09.2005. Parasitization was found to be low in August-September. On the shoots, the second stage larvae, the virgin females and parasitized individuals were seen from January to September, from March to September, and from April to September, respectively. On the leaves, all the stages of the pest were seen in varying amounts throughout the year and the parasitization according to the pest population was detected all year round. On the fruit, the second stage larvae and virgin females were seen in January-February and June-October. The parasitization was determined in July-September and reached to the highest level in August (Fig. 7). Yu (1986) Murdoch et al. (1989), Yu et al. (1990) reported that active larvae of the red scale on the shoots colonize on the new crop fruits and thus the parasitoid releases are effective in the control of the red scale on the fruits. Similar results were obtained in the lemon control orchard in Mersin/Erdemli in 2005 (Fig. 8). Parasitization rate on stem, shoot, leaf and fruit in parasitoid released plot and control plot are given Table 1.

The parasitization rate was the lowest on the stem, followed by the shoot and leaf and the highest on the fruit. The differences in respect to the parasitization rate on different parts of trees were significant. Similarly, Yu (1986), Yu et al. (1990) and Borer et al. (2004) pointed out that the parasitization percentage both on the fruit and leaves was higher with regard to the shoots. The high amount of parasitization on the fruit and leaf is related to the size of the host. Parasitoids prefer bigger red scale. As the red scale is bigger on the leaf and fruit, the parasitization has been found to be higher. Many studies have shown strong effects of host quality on parasitization (Harvey et al. 1995, Jervis & Kidd 1996). Walde et al. (1989) identified a possible reason for this attraction: on average, scale insects on leaves are somewhat larger than scale insects on stems.

Table 1. Parasitization rate of California red scale in Kozan and Erdemli (%).

Place / Variety / Date	Parasitization rate %			
	Stem	Shoot	Leaf	Fruit
Kozan Lemon 2004 (release)	2.4	7.1	61.9	76.5
Kozan Lemon 2005 (release)	2.3	19.4	44.1	79.8
Kozan Lemon Control 2004	5.7	37.9	31.4	51.0
Kozan Lemon Control 2005	15.8	36.0	36.0	52.3
Erdemli Lemon 2004 (release)	11.1	57.7	60.4	89.0
Erdemli Lemon 2005 (release)	6.0	45.0	78.0	49.0
Erdemli Lemon Control 2004	8.8	53.3	40.9	61.5
Erdemli Lemon Control 2005	5.9	48.2	44.9	46.8

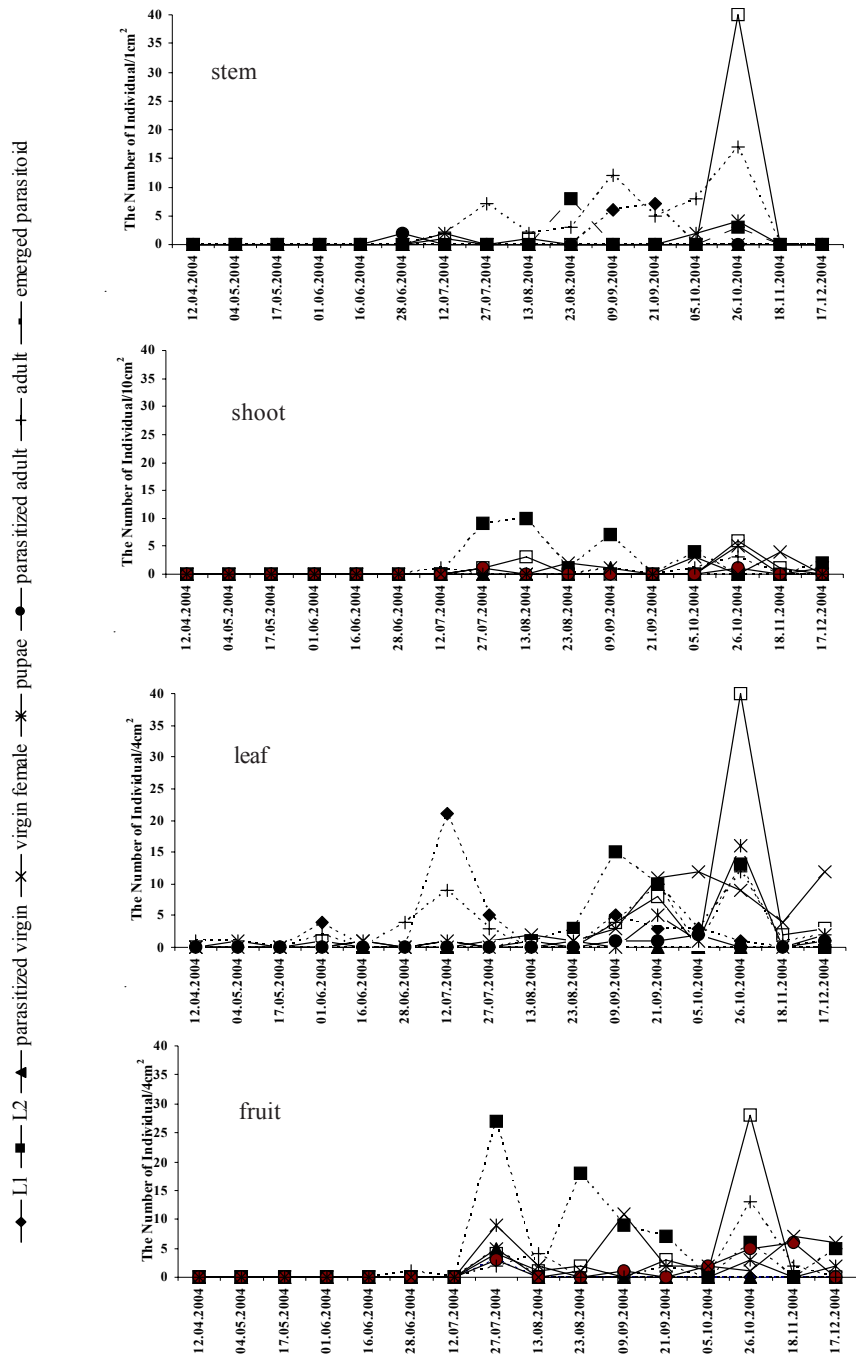


Fig. 6. Population movement of *A. aurantii* in control plot in lemon orchards in Erdemli/Mersin in 2004.

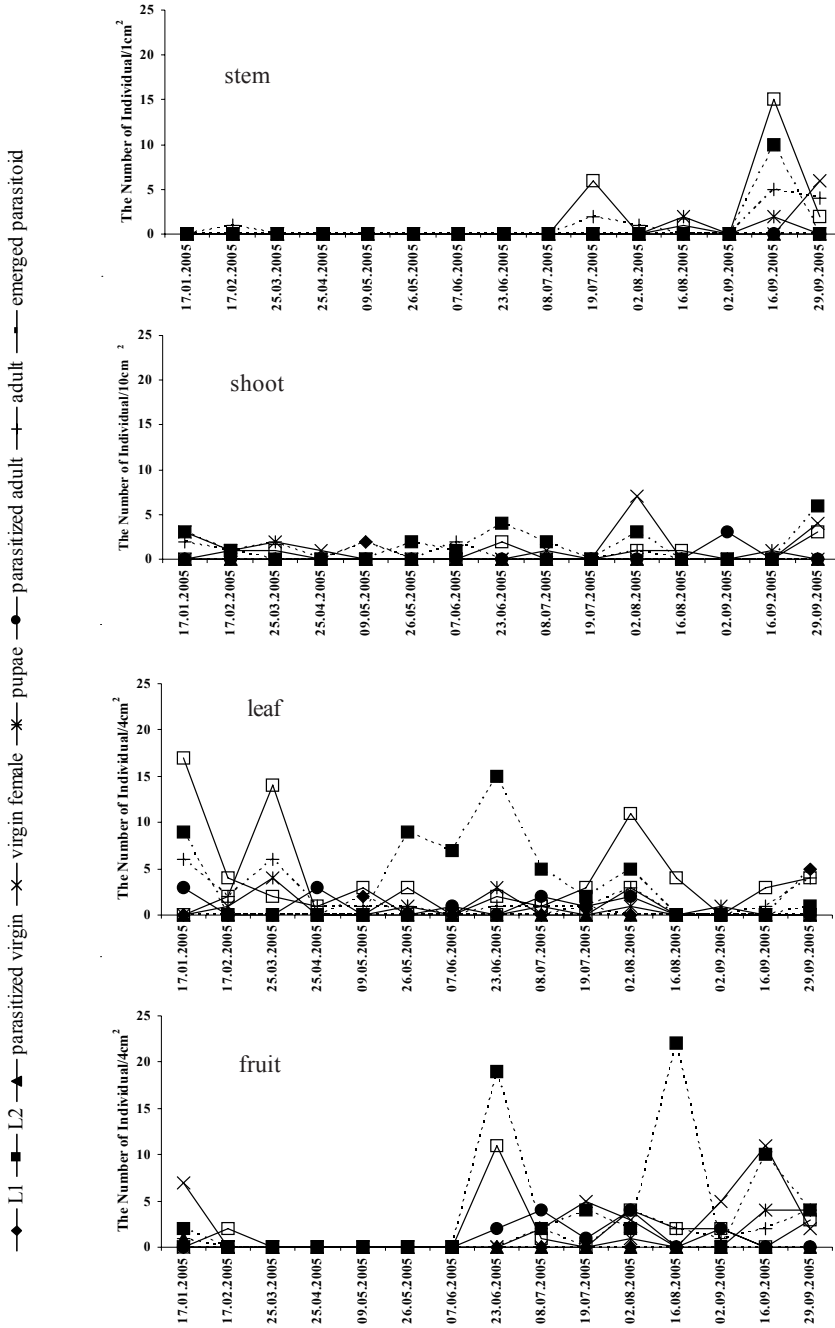


Fig. 7. Population movement of *A. aurantii* in released plot in lemon orchards in Erdemli/Mersin in 2005.

