



ISSN 2347-2677

IJFBS 2019; 6(6): 45-50

Received: 28-09-2019

Accepted: 30-10-2019

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Population dynamics of chaff scale [*Parlatoria pergandii* (Comstock) (Hemiptera: Diaspididae)] and its parasitoids on three citrus species in Hatay, Turkey

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Abstract

Chaff scale, *Parlatoria pergandii* (Comstock) (Hemiptera: Diaspididae) is a cosmopolitan and polyphagous pest worldwide. It causes characteristic green spottings on fruits decreasing its market value, desiccate of leaves and branches and at high infestations drop of the fruits. This study was carried out to determine the population dynamics of *P. pergandii* and its parasitoids in Hatay (Turkey) province on orange, mandarin and grapefruit in 2012-2013. Data revealed that the common abundance was recorded on orange followed by mandarin and the least on grapefruit as the same sorting for the parasitization rate. There were three highly variation periods of the pest and the population reached the maximum during July, August and October in both growing seasons at all citrus species. Pest population was higher on leaves than branches then the fruits, respectively but the parasitization rate was highest on fruits followed by leaves then the branches at all citrus species. It was concluded that the first generation, which was corresponded to the first half of July, must be taken as the basis for the control of the pest.

Keywords: Citrus, *parlatoria pergandii*, population fluctuation, *aphytis melinus* debach

1. Introduction

Citrus is one of the most important fruit group cultivated in the world and Turkey. In Turkey, the number of citrus orchards are increasing every year with a total annual production of ~3.9 million tonnes (Anonymous, 2016) ^[1]. It's predominantly produced in the east Mediterranean region. However, in addition to the problems of breeding and marketing, there are various diseases and pest species found during production. There are more than 90 pests species, 34 diseases species, 16 nematodes, and 155 weed species in citrus cultivating areas in Turkey (Uygun *et al.*, 2001; Uygun and Satar, 2008) ^[2, 3]. The Chaff scale, *Parlatoria pergandii* (Comstock) (Hemiptera: Diaspididae) is one of the citrus pests widely - distributed cosmopolitan species infesting citrus worldwide and in Turkey. It is a pest of mature citrus groves along the coastal plain of Turkey. *P. pergandii* infestations can be recognized by the presence of the scale-armour on stems, leaves and fruits of hosts. Symptoms are generally related to the severity of attack (population density on host). When fruits are infested with *P. pergandii*, spotting occurs, with a characteristic green spotting on oranges. Infestations on the leaves and stems may cause wilting and may reduce the photosynthetic area of the plants, leading to lower yield. On citrus trees, infestations may cause gumming, flaking and cracking of the bark, killing branches and sometimes, whole trees (Gerson, 2012) ^[4]. *P. pergandii*, previously known as a citrus pest in Turkey, is often confused with some other diaspidid species by the farmers. In recent years, especially in Hatay, the citrus samples with the assumption that it was infected with California red scale, *Aonidiella aurantii* (Maskell) (Hemiptera: Diaspididae), this pest was frequently encountered. It has been determined that the population of the pest was increased in the citrus areas and growers have failed to control the pest with insecticides. It is noted that *P. pergandii* in Turkey has markedly increased population density in the citrus fields of the eastern Mediterranean region in recent years and that it is among the species to be watched out (Uygun *et al.*, 2010) ^[5]. Ülgentürk *et al.* (2014) ^[6] identified a total of 11 Coccoidea species in the fruits and seedlings were recorded during controls in the neighborhood markets and markets in Ankara in 2008-2013. From these species, *P. pergandii* was found to be the most common one on citrus fruits after *A. aurantii*. It has been emphasized that the pest can cause significant damages on citrus in the future. Reducing *P. pergandii* densities to low levels by various control methods is considered of vital

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importance. Natural biological control by its parasitoids and predators is an environmentally friendly method (Erlor and Tunç, 2001; Karaca *et al.*, 2001; Abd-Rabou, 2011) [7, 8, 9]. There is limited study about Chaff scale and its control in citrus orchards in Turkey. In this study, pest development, population fluctuation of the pest and its parasitoids were investigated.

2. Materials and Methods

The field work was conducted on 5 ha, 17-year-old citrus orchard mix cultivation of orange (Washington navel), mandarin (Fremont) and grapefruit (Marsh seedless), infested with *P. pergandii* in Erzin (Hatay), in eastern Mediterranean region of Turkey. The infestation level of scales was evaluated from samples of 5 trees chosen randomly for each varieties. Ten pieces of branches with 20 cm long were collected from each of five randomly chosen trees at 1.5-2.0 m height. For to detect the infestation on fruits, 10 fruits (2 fruits for each tree x 5 trees = 10 fruits) for each variety were collected (Karaca *et al.*, 2001) [8]. Samples were transferred to the laboratory and alive and parasitized *P. pergandii*

individuals were recorded under the stereo binocular microscope. For the determination of the parasitoid species of *P. pergandii*, branches (20cm long) contaminated with the pest were cultured after cleaning from pests except the pest species. By making use of the light seeking feature of *P. pergandii* parasitoids, the branches contaminated with *P. pergandii* were placed in darkened (with black polyethylene) plastic jars to obtain parasitoids. A glass tube was placed to the open side of the jar to collect the parasitoids and controlled once a day. Samples were taken weekly during April - October and monthly during the winter months. The study was conducted during 2012 and 2013. Chemical insecticides were not applied to the orchard during the period of the study.

3. Results and Discussion

Population dynamics of *P. pergandii* and parasitized individuals on leaves, branches and fruits of orange (Washington navel), mandarin (Fremont) and grapefruit (Marsh seedless) in 2012 and 2013 are given in Fig. 1-6

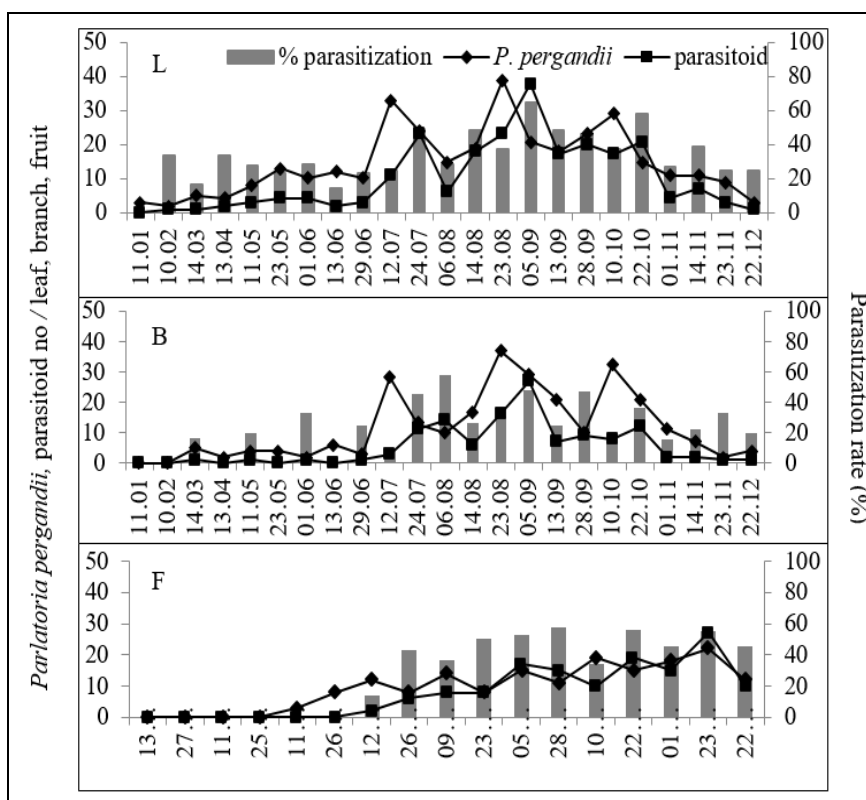


Fig 1: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of orange respectively and parasitization rate (%) in 2012.

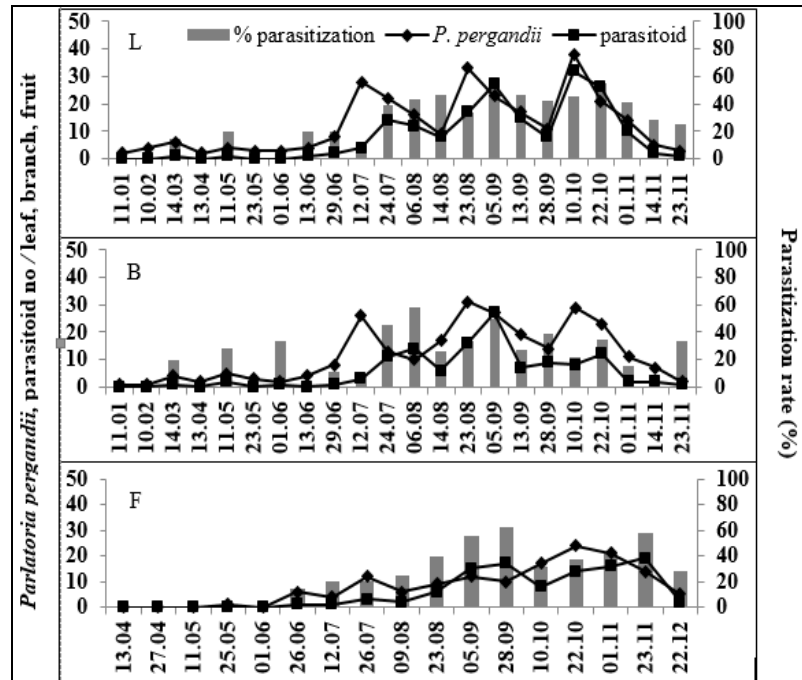


Fig 2: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of mandarin respectively and parasitization rate (%) in 2012

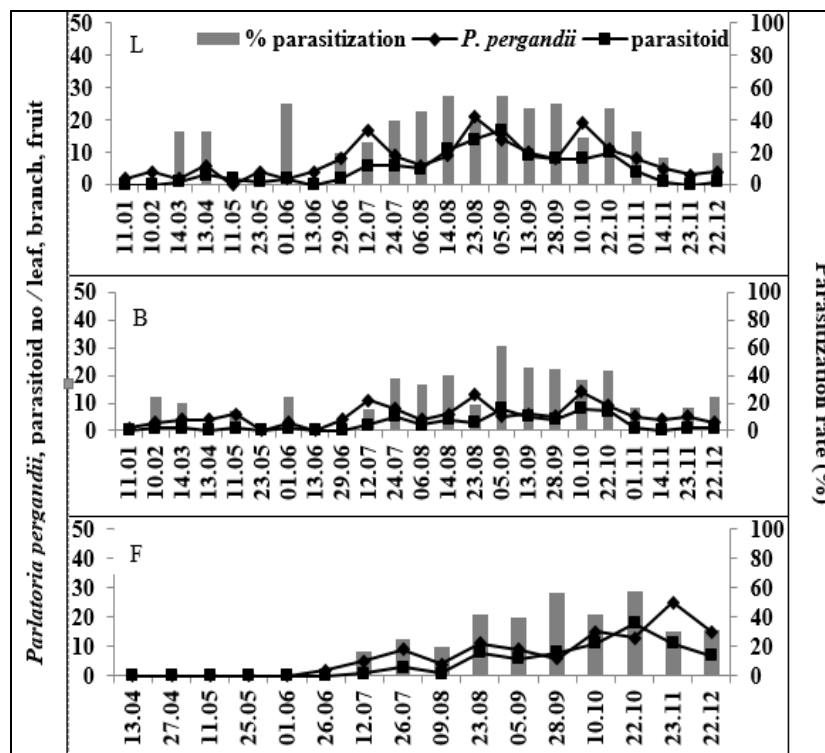


Fig 3: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of grapefruit respectively and parasitization rate (%) in 2012.

From Fig. 1, on orange the population of *P. pergandii* was highest on leaf (14.65 individuals) followed by population on branch (11.65 individuals). Parasitization rate on fruit was higher (37.75%) than leaf (34.48%) and branch (25.82%). The population of *P. pergandii* was highest on mandarin leaf (14.55 individuals) followed by population on branch (13.94 individuals). Parasitization on fruit was highest (36.34%) followed by leaf and branch (Fig. 2). On grapefruit, the pest population was lower than orange and mandarin on leaf, branch and fruit (Fig. 3). The population was highest in 12 July, 23 August and 10 October in three of the

varieties and it was conducted that at these dates the pest had generations. It was conducted that the pest had 3 generations and these generations were lasted for 40-50 days. In all three citrus species, parasitization increased by August. *Aphytis melinus* DeBach (Hymenoptera: Aphelinidae) was the dominant parasitoid species. The other parasitoid species were: *Comperiella bifasciata* (Howard) (Hymenoptera: Encyrtidae), *A. hispanicus* (Mercet), *A. proclia* (Walker), *Encarsia citrina* (Craw.) (Aphelinidae) (Elekcioglu and Olçülü, 2018) [10].

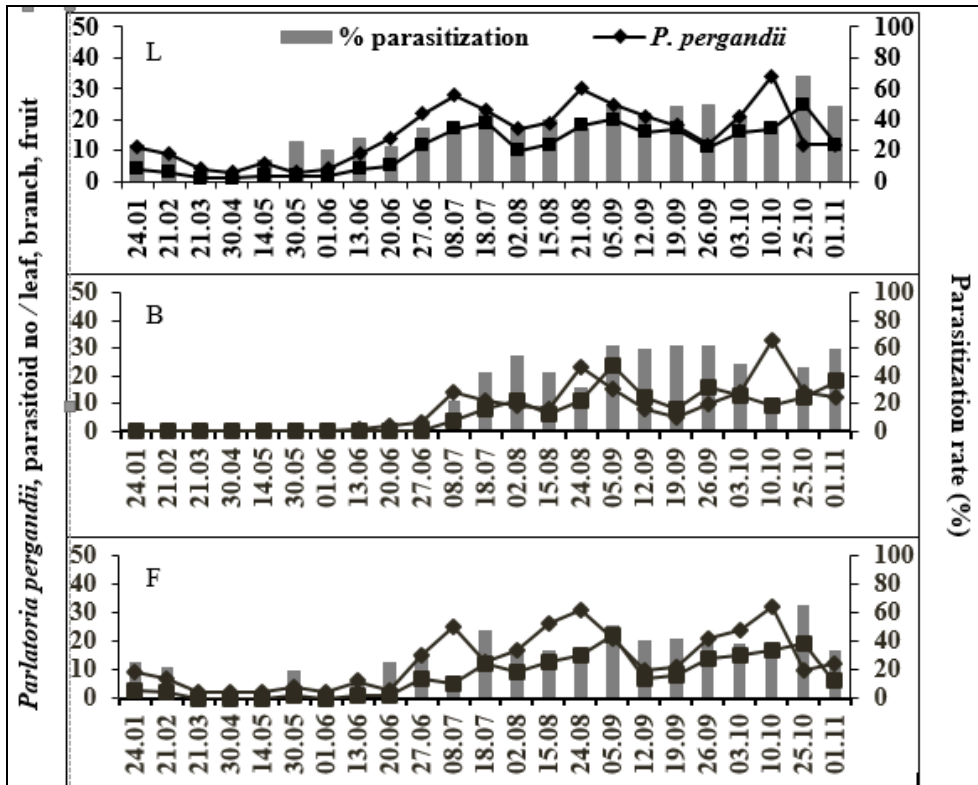


Fig 4: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of orange respectively and parasitization rate (%) in 2013

From Fig. 4, on orange the population of *P. pergandii* was highest on leaf (15.09 individuals) followed by population on branch (13.27 individuals). Parasitization rate on fruit was higher than leaf (32.44%) and branch (28.26%). The population of *P. pergandii* was highest on mandarin leaf (12.87 individuals) followed by population on branch (11.61

individuals). Parasitization on fruit was highest followed by leaf and branch (Fig. 5). On grapefruit, the pest population was lower than orange and mandarin on leaf, branch and fruit (Fig. 6). The population was highest in 8 July, 24 August and 10 October in 2013 at three of the varieties and it was conducted that at these dates the pest had generations.

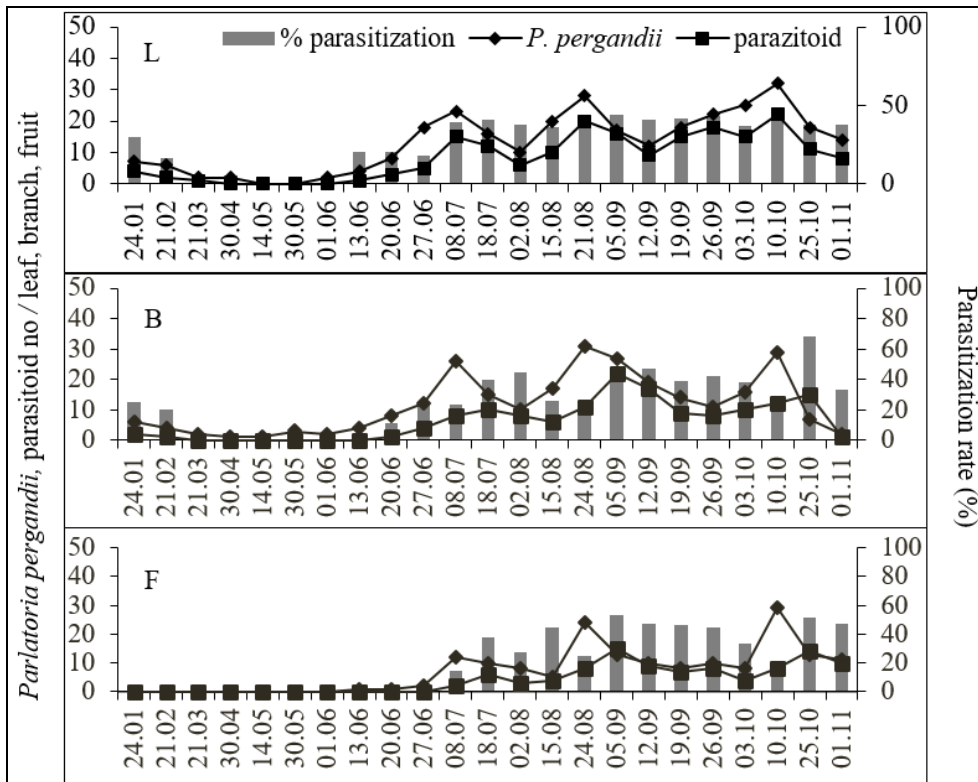


Fig 5: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of mandarin respectively and parasitization rate (%) in 2013.

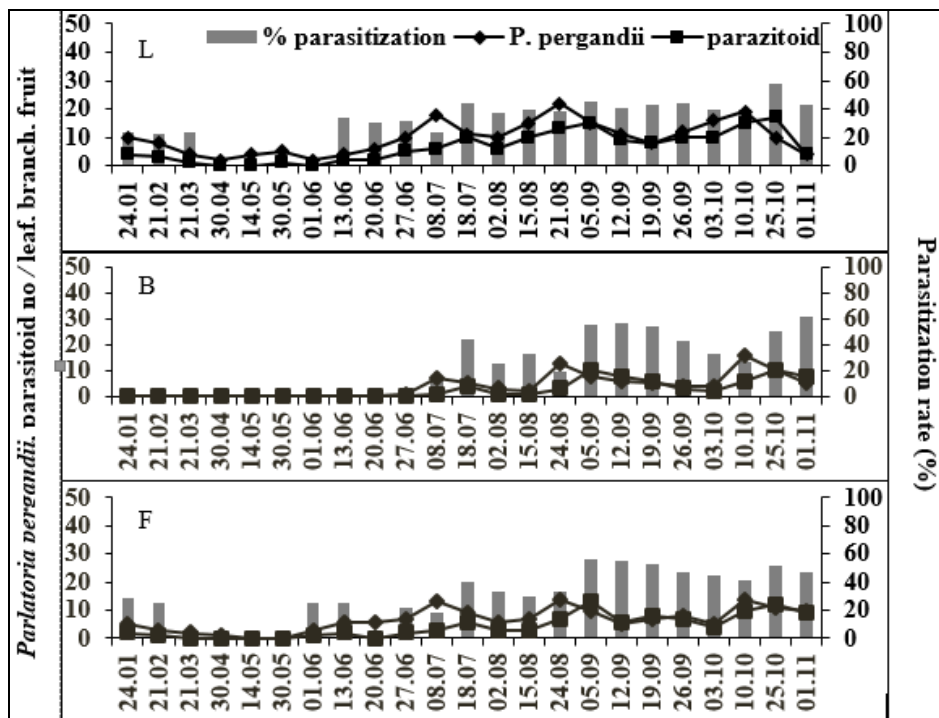


Fig 6: Population dynamics of *Parlatoria pergandii* and parasitoids on leaf (L), Branch (B) and fruit (F) of grapefruit respectively and parasitization rate (%) in 2013

From the two years study, it was conducted that the pest had 3 generations and these generations were lasted for 40-50 days. Uygun *et al.* (2010) [5] indicated that *P. pergandii* had 3 generations per year in Turkey which matches well with the result of this study. The pest had 3-4 generations in Israel, 4 in Florida, 3 in Alabama, 3 in Spain and 5-6 in Australia (Gerson, 1967; Rodrigo *et al.*, 2004; Jendoubi, 2012) [11, 12, 13]. It was observed a high decrease with the defoliation before spring on *P. pergandii* overwintered individuals. In the forthcoming months female individuals increased in total 4 periods which are April-May, July-June, August-September and October-November. Parasitoid individuals increased in some periods when the population of scale insects increased in west Mediterranean region of Turkey (Bayındır and Karaca, 2015) [14]. It is thought that different climatic and ecological conditions at different countries and localities resulted different generation numbers. In three of the citrus species, parasitization increased by August in 2013 and *A. melinus* was the dominant parasitoid species as in 2012. Parasitization rate was between 26.97%-37.29% according to the plant part and variety. Parasitization rate was highest at 2nd instar and virgin stages. Karaca *et al.* (2001) [8] conducted that *A. melinus* could successfully control *P. pergandii* populations in citrus orchards in Çukurova region of Turkey and stabilises its population at low levels for a long period. *Aphytis proclia* (Walker), *A. maculicornis* Masi, *A. hispanicus* Mercet, *Apterencyrtus* sp. were recorded as the parasitoids of *P. pergandii* in citrus orchards in Turkey (Uygun, 2003) [15]. The most widespread scale insect and its parasitoid species in Syria were *P. pergandii* and *A. melinus*, respectively (Ghazal, 2006) [16]. Atkinson (1977) [17] determined that *Aphytis* species parasitized *A. aurantii* which is on fruit and leaf more than individuals on branch. *A. melinus* parasitized *A. aurantii* individuals which is on fruit more than scales on leaf and trunk (Karaca, 1998) [18]. The results of this study matches well with literature, that parasitoids prefers primarily *P. pergandii* feeding on fruit than leaves and least on branch. It

is indicated that the attractive effect of fruit color on parasitoids and also the body size of *P. pergandii* feeding on fruits and leaves (larger when compared with other plant parts) and therefore they are more suitable host for the parasitoid (Karaca and Uygun, 1990) [19].

4. Conclusions

P. pergandii and parasitoid population was highest on orange followed by mandarin and grapefruit and highest on leaf followed by branch and fruit respectively at all citrus varieties. But parasitization rate was highest on fruit than leaf and branch. In all three citrus species, parasitization increased by August and highest during autumn. It has been determined that if the pest is contaminated with fruit, it is first placed under the calyx and could be escaped if the calyx observations is not done properly during the visual control. It was concluded that the first generation of the pest which was corresponded the first half of July must be targeted for the pest control. So, the time of the first generation must be conducted properly and the control plan must be done accordingly.

5. Acknowledgements

The authors are thankful to Biological Control Research Institute (Adana) for financial support (Project number: TAGEM-BS-12/08-02/01-22).

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