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Full Length Article

Effect of Releasing the Parasitoid, *Aphidius colemani* (Hymenoptera: Braconidae) on Suppression of *Myzus persicae* (Hemiptera: Aphididae) Populations in Eggplants

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Abstract

In Turkey, the polyphagous aphid, *Myzus persicae* Sulz. (Hemiptera: Aphididae) causes economic damages to eggplant. The solitary koinobiont parasitoid, *Aphidius colemani* Viereck (Hymenoptera: Braconidae) is the mainly used parasitoid and commercially available in greenhouse crops. This study investigated the efficacy of *A. colemani* to suppress *M. persicae* on greenhouse grown eggplant during early fall and spring seasons. Both early fall and spring plastic greenhouse experiments showed that *A. colemani* significantly reduced aphid densities compared with the control treatment, but aphids' density was over the economic threshold in release treatment. The maximum parasitism rates achieved in early fall and spring experiments were 38.84 and 94.6%, respectively. Various factors, affect the efficacy of the parasitic wasp (*A. colemani*) on eggplants were discussed. © 2018 Friends Science Publishers

Keywords: Biological control; Plastic greenhouse; Aphid; Parasitism; *Solanum melongena*

Introduction

The structure of greenhouses, varying from simple to sophisticated, depending on climate and covering material impacts crop protection techniques, which are used against pest and disease. There are two types greenhouse depending on climate of the country where it is established; the one of them is common throughout coastal areas of the Mediterranean and provides minimal climatic conditions for growing the crops (Gullino *et al*., 1999). In Turkey, eggplants (*Solanum melongena*) are planted in late summer or early fall (September through October) and harvested from late fall through spring months into greenhouses consisting of simple plastic tunnels. On the other hand, eggplant may also be planted in late winter (February through March), and harvested in late spring and early summer.

The polyphagous aphid, *Myzus persicae* Sulz. (Hemiptera: Aphididae) is a phloem feeder (Pollard, 1973). Feeding results to severe distortion plant growth (Lodos, 1982). Additionally, *M. persicae* produces large amounts of honeydew resulting in a sooty molt which reduces photosynthesis (Lodos, 1982). Populations of aphids have been controlled by different methods in the Mediterranean coast of Turkey. The increasing use of biological control agents, such as parasitic wasps against whitefly, predatory mites against thrips and mite pests induce fighting aphids with compatible measures against other pests are the main method. Several researchers interested in biological control of aphids suggested the parasitic wasp, *Aphidius colemani* Viereck (Hymenoptera: Braconidae). It parasitizes both adult and nymphal stages of aphid species. Parasitized aphids are easily recognized by their mummified formation. *A. colemani* has a good searching capacity and can lay hundreds of eggs during its life span. The strategy aphids-parasitoid control systems in greenhouse crops are releasing parasitoids as soon as aphids are detected. However, there is little information about inundative release strategy of *A. colemani* when the *M. persicae* population is high. This study investigated the potential of *A. colemani* on greenhouse grown eggplant to suppress *M. persicae* along production season in Mediterranean cost of Turkey.

Material and Methods

Host Plant Culture

Chinese cabbage (*Brassica rapa* L.) was sown singly in pots to produce robust plant ready for infestation with aphids after 4–7 weeks.

M. persicae Culture

Two cheese-cloth covered cages of 70 × 55 × 40 cm in

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length, width and height, respectively were accommodated in a greenhouse. Ten plants were caged every week and each was infested with 10–20 aphids by introducing an aphid-infested leaf. At 20–25°C about thousand aphids were produced in 2 weeks. One plant was kept to maintain the aphid stocks, while others were used to rear the parasitoid.

A. colemani Culture

Mummified aphids were collected from cotton field in the east Mediterranean Region of Turkey and adult parasitoids were obtained from these samples. Nickolas G. Kavallieratos (Benaki Phytopathological Institute, Greece) identified parasitoid species as *A. colemani.*

A similar cheese-cloth cage was used to rear *A. colemani*. Weekly, 2–3 Chinese cabbage plants infested with aphids were introduced into a cage together with about 30 mummies containing the parasitoid pupae of *A. colemani.*

Plastic Greenhouse Experiment (Early Fall and Spring)

Plastic greenhouses at the Adana Plant Protection Research Institute, Turkey were used to carry out experiments in early fall and spring. In the greenhouse, eggplants "Aydin Black" were planted in rows, each with 10 plants on 18th of September 2015 and 16th of March 2016. At the same date, for 4 treatment and 4 control, totally.8 exclusion cages of 2 x 2 x 1 m in length, width and height, respectively, their sides were covered with cheese-cloth, covering 10 eggplants, was placed in the greenhouse for each year. Approximately one month after planting the eggplant on 22nd of October 2015 and 5th of April 2016; the eggplants in all cages were infested with 10 aphids per plant by introducing aphid-infested leaves. To evaluate colonization and control efficiency of *A. colemani*, parasitoid adults reared were singly released directly on different plants at sundown at the rate of 100 adults per cage (10 adults per eggplant) into four release cages (4 replication) one week after aphid infestation on 29th of October 2015 and 13th of April 2016. On that date, the pest population was above 10 aphids per leaf. Four non-release cages were assessed as control cages. Sampling started on 5th of November 2015 and 20th of April 2016 and conducted weekly to monitor the population dynamics of *M. persicae* and the parasitoid. Total nine and eight samplings were conducted from 5 November 2015 to 30 December 2015 and from 20 April 2016 to 8 June 2016, respectively. All aphids on each sample leaves selected from five plants per cage were counted with the aid of a magnifier glass (5x magnification). It provided an average estimation of aphid density per cage. The numbers of mummified aphids per leaf were counted to estimate parasitism levels. HOBO (Onset Computer, Bourne, MA, USA) data loggers were used to monitor temperature and relative humidity during the experiment.

Data Analysis

A repeated-measures ANOVA was run on mean densities of *M. persicae* for statistical analyses. The introduction date of parasitoid was chosen as the repeated measure variable. Student's t-tests at a 5% confidence level was performed to differentiate between treatment and control in both experiments. Suppression rate of *M. persicae* achieved with parasitoid was calculated as 100 × [1-(density of *M. persicae* in the release cage/density of *M. persicae* in the control cage)].

Results

Early Fall Experiment

Average number of *M. persicae* per leaf was significantly different between the release and control treatments (F (1, 6)= 102.876; P<0.001). Additionally, the effect of date (F (9, 54) = 16.215; P <0.001) and the treatment x date interaction (F (9, 54) = 5.914; P<0.001) were both significant with higher *M. persicae* numbers observed in the untreated plants than in the treatment on every sample date except for week 1 and 2 after parasitoid release in early fall experiments 2015 (Fig. 1). Always upward trends were seen in aphid populations in the control cage. However, *M. persicae* numbers were kept in intermediate level in the parasitoid release treatment along the study. Numbers of aphids on control cages reached almost 2500 individuals per leaf on 17th of December, falling to about half that value during the subsequent week, compared to 1060 or less on *A. colemani* plants (Fig. 1). Nevertheless, aphid densities were generally maintained around 500 individuals per leaf in response to the release of parasitoid except in week 7 (17.12.2015) when they reached to 1060 per leaf. Aphid population reductions of 71, 27, 84, 82, 80, 72, 61, 89 and 97% were observed by the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th and 9th week after parasitoid release, respectively.

Rate of parasitism estimated number of mummified aphids found on the leaf samples of the treated cages with *A. colemani* varied from 0.85 to 38.84% being the highest on 3rd of December. One week after the first parasitoid release, parasitism level was 14.01% and increased fairly until the week5, when parasitism level was 38.84%, except for week 2 (Fig. 1).

Spring Experiment

Aphid densities were also significantly different between the release and control treatments [Fig. 2; F (1, 6) = 248,66, P<0.001], aphid populations fell from 45 to 1047 per leaf being highest on May 11th in released plot, while in the control plot this level increased to 1649 per leaf being highest on May 4th.

In addition, the effect of date (F (8, 48) = 68,1;

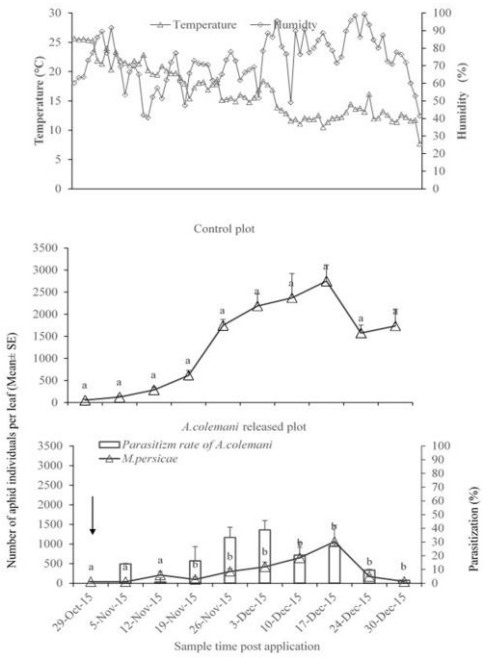

Fig. 1: Results of a single release impact of *A. colemani* on *M. persicae* in greenhouse grown with eggplant in early fall months

Arrow indicate the dates of release of *A. colemani*

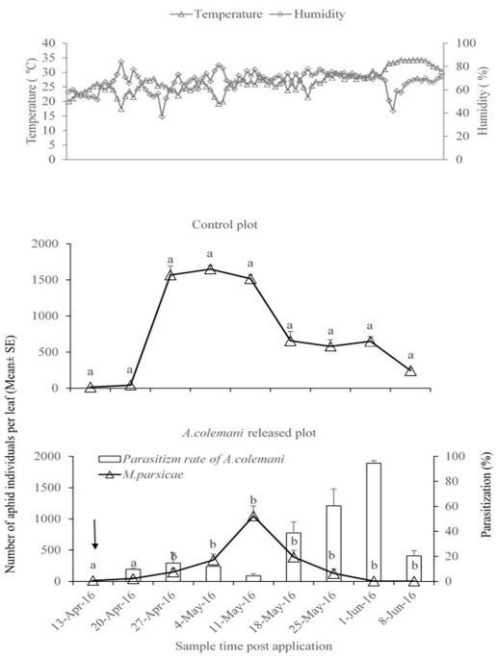

Fig. 2: Results of a single release impact of *A. colemani* on *M. persicae* in greenhouse grown with eggplant in spring months

Arrow indicate the dates of release of *A. colemani*

P<0.001) and the treatment x date interaction (*F* (8, 48) =22,31; *P*<0.001) were both significant with higher *M. persicae* numbers observed in the untreated control than in release treatment on every sample date (Fig. 2). Aphid population reductions of 0.0, 90.4, 79.2, 31.0, 40.6, 77.7, 99.3 and 99.2% were observed by the 1th, 2th, 3th, 4th, 5th, 6th, 7thand 8th week after parasitoid release in release plots, respectively. The percentage of parasitized aphids ranged between 9.7 and 94.6% through the study in *A. colemani* release cages as the highest on 1th of June (week 8) (Fig. 2).

Discussion

In this study, suppression of aphid populations below the action threshold of 20 aphids per leaf (Yücel *et al*., 2011) was expected in *A. colemani* release plots. Both early fall and spring plastic greenhouse experiments showed that release of *A. colemani* just significantly reduced aphid densities than the control treatment. However, aphids' density was over the action threshold of 20 aphids per leaf in release treatment.

Lack of efficacy of single *A. colemani* releasing in controlling *M. persicae* on eggplants may be caused by various factors. Khatri *et al.* (2017) suggested that the first three weeks after aphid populations settled in greenhouse are the critical period for the augmentation of parasitoids, because fluctuations of population dynamics will strongly be affected by initial parasitoid-host ratios (Tremblay, 1974). Moon *et al.* (2011) released two parasitoid mummies of *A. colemani* per square meter three times in early season to control *A. gossypii* in glasshouses and aphid populations fell 1 to 0.6 per leaf in released plot, while in the control plot this level increased to 653.2 per leaf. In early fall and spring experiment, result of this study showed that at a high initial aphid population level, *A. colemani* was unable to cope with the host growth rate. Therefore, more than one release was highly needed. Athanassiou *et al*. (2003), Kavallieratos *et al*. (2005) reported that peak *M. persicae* population density could reach 750 and 2500 aphids per leaf on tobacco, respectively, which is difficult to control through the release of *A. colemani.* Rabasse and van Steenis (1999) stated that inoculative releases of *A. colemani* were not always able to prevent outbreaks of *M. persicae.* Albittar *et al.* (2016) found that the host plant played a significant role in host acceptance and host suitability for aphid parasitoids. *A. colemani* accepts a host more readily on cucumber than on eggplant (Messing and Rabasse, 1995). Koppert (2017) advises to release 0.1–0.25 *A. colemani* mummies per square meter before the pest settled or 1–5 *A. colemani* mummies per square meter at least three to six time releases after the pest settled over several weeks.

Biological control programs conducted in greenhouses are affected alone or in combination with biotic and abiotic factors. In early fall experiment, temperature was around or below 13°C from the end of November until the end of experiment. Due to this drop in temperature, parasitism rate

which was 38.84% on 3rd of December began to fall from that date (Fig. 1). *A. colemani* populations affected by the low temperature with the fastest development between 22°C and 28°C (Van Steenis, 1993; Goh *et al.*, 2001). Effects of *A. colemani* decreased linearly with temperature (Zamani *et al*., 2006). Tremblay (1974) suggested that environments where the temperature varied from 8 to 20°C, the aphid populations was not economically affected by the parasitoid populations. On the other hand, in spring experiment, the temperature ranged 20–25°C from April to June, reached above 30°C from June. As a result of this increase in temperature, parasitism rate which was 94.6% on 1st of June began to drop (Fig. 2). In this study, the maximum parasitism rates those were achieved in early fall and spring experiments were approximately 50 to 60% more than early fall one.

Conclusion

In order to achieve success in the biological control of *M. persicae* with *A. colemani*, the temperature degree and the parasitoid-host ratio should be considered. Further studies are needed on augmentative releases of *A. colemani*. Also choosing a suitable parasitoid species should be considered before using it against certain host species.

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