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Predacious activity of *Serangium parcesetosum* Sicard (Coleoptera: Coccinellidae) on *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) on caged tomato

Serangium parcesetosum Sicard (Coleoptera: Coccinellidae)'un Domates Serasında Beyazsinek, *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) Üzerinde Avcı Aktivitesi

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Abstract: Tomatoes are the most familiar and the most common greenhouse vegetable crop in Turkey, as well as worldwide. Main whitefly species problematic in the greenhouses, where tomatoes grown primarily, is *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) in Mediterranean Region of Turkey. *Serangium parcesetosum* Sicard (Coleoptera: Coccinellidae) is proved as a coccinellid predator of *B. tabaci* and a voracious feeder by several studies. The hypothesis "the outcome of a biological control program is determined by the initial pest to predator ratio" was examined on caged tomato in greenhouses. The current study showed the influence of initial whitefly density on the whitefly population growth rate, which was independent of the absence or presence of *S. parcesetosum* (P> 0.05) for the whitefly density × predator release interaction). No significant differences in whitefly suppression from *S. parcesetosum* predation were monitored between the two initial whitefly densities in both years. The density of the pest was reduced by *S. parcesetosum* in high and moderate initial whitefly density cages 2-3 weeks after releasing the ladybird beetles. During the experiment, copulating adults, larvae, and pupae of the predatory ladybird beetle were observed in both predator-releasing cages. These results indicated that *S. parcesetosum* can survive and reproduce on tomato plants in greenhouse production during the spring months in Mediterraenean region of Turkey.

Anahtar Kelimeler: *Bemisia tabaci, Serangium parcesetosum,* biological control, plastic greenhouse, tomato

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Öz: Domates, tüm dünyada olduğu gibi Türkiye'de de en yaygın olarak yetiştirilen örtü altı sebzesidir. Türkiye'nin Akdeniz Bölgesi'nde domates yetiştirilen seralarda sorun olan yaygın beyazsinek türü *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae)'dir. Yürütülen çeşitli çalışmalar ile *Serangium parcesetosum* Sicard (Coleoptera: Coccinellidae)'un *B. tabaci*'nin oburca beslenen bir coccinelld avcısı olduğu kanıtlanmıştır. "Biyolojik mücadelenin sonucu, salım zamanı uygulanan av/avcı oranına göre belirlenir" hipotezi, domates serasında kafes içerisindeki domatesler üzerinde incelenmiştir. Bu çalışmada, beyazsineğin başlangıç yoğunluğunun populasyon artışına olan etkisi avcı, *S. parcesetosum* salımından bağımsız olarak etki göstermiştir (P> 0.05 beyazsinek yoğunluğu x avcı salım interaksiyonu). Her iki yılda da beyazsinek başlangıç yoğunlukları ile avcı *S. parcesetosum* etkileşiminde beyaz sineğin kontrol altına alınmasında önemli bir fark görülmedi. Beyazsineğin başlangıç yoğunluğu orta ve yüksek olan her iki kafeslerdede avcı, *S. parcesetosum* salındıktan 2-3 hafta sonra beyazsinek yoğunluğu avcı tarafından azaltılmıştır. Çalışma süresince, avcı gelin böceği, *S. parcesetosum*'un çiftleşen erginleri, larvaları ve pupaları, avcının salımının yapıldığı tüm kafeslerde görüldü. Bu sonuçlar, *S. parcesetosum*'un Türkiye'de ilkbahar aylarında örtü altında yetiştirilen domates bitkilerinin üzerinde Beyazsinekle beslenerek yaşayabildiğini ve çoğalabildiğini ortaya koymuştur.

Keywords: *Bemisia tabaci, Serangium parcesetosum,* biyolojik mücadelel, plastik sera, domates

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INTRODUCTION

The main whitefly species causing problems on tomatoes grown in the greenhouses is *Bemisia tabaci* Genn. (Hemiptera: Aleyrodidae) in the Mediterranean Region of Turkey (Ulubilir and Yabas, 1996; Ulubilir et al., 1999). Whiteflies can seriously damage the crops by sucking the sap, causing leaves to yellow, shrivel, and drop prematurely, as a vector of viruses such as Tomato yellow leaf curl virus (TYLCV), and secreting honeydew, causing sooty-mold growth on leaves covered with honeydew excreted by the pest (Perring, 2001). The economic thresholds of the pest populations can be rapidly reached unless effective controls measures. The management of *B. tabaci* is based on the heavily application of pesticides. In recent years, environmental concerns about pesticide contamination of soil, water, and air have led policy makers to launch ambitious programs to reduce the number of pesticide applications used in agricultural ecosystems. Farmers producing tomato in Turkey are willing to apply mostly biological control agents against pests, because of the problem of pesticide residue on tomato crop (Yucel et al., 1995, 1996; Ulubilir et al., 1998; Karut, 2007). Non-glandular and glandular trichomes in foliage and stems of tomato plants have a negative effect, reduce the mobility of predators and make the search behaviour of predators more difficult. In addition, the glandular trichomes produce toxic exudates having potentially poisonous to natural enemies of pests. Non-glandular and glandular trichomes in foliage and stems of tomato plants have a negative effect, reduce the mobility of predators and make the search behaviour of predators more difficult. Consequently, establishing a biological control program against *B. tabaci* on tomato is more difficult (Stansly et al., 2004). Commonly natural enemies of *B. tabaci* on tomato plants in greenhouses in the Mediterranean countries are the predator *Nesidiocoris tenuis* Reuter (Hem.: Miridae) and the parasitoid, *Eretmocerus mundus* Mercet (Hym.: Aphelinidae) (Albajes and Alomar, 1999; van der Blom, 2002; Sanchez et al., 2003). The success of natural enemies of whitefly depends on their ability to live on tomato plants with glandular trichomes (Stansly et al., 2005). Biological control of *B. tabaci* in greenhouses requires more careful monitoring, increased parasitoid releasing, and/ or the use of additional natural enemies (van Lenteren and Martin, 1999).

Solanaceous species, including tomato are not preferred by natural enemies because of their hairy trichomes, which prevent the movement of predators and parasitoids (Bottrell, 1998). Although the number of natural enemies used against *B. tabaci* on greenhouse-grown tomato is limited, *S. parcesetosum* has a positive result in biological control of *B. tabaci* on greenhouse in which eggplant is grown (Kutuk et al., 2008).

Laboratory studies have shown that both larvae and adults of *Serangium* are voracious feeders, capable of consuming large numbers of immature silverleaf whiteflies in a short period. Legaspi et al. (1996) demonstrated that adults consumed approximately 400 whitefly nymphs in 24 hours and the cumulative lifetime predation rate was approximately 5,000 whitefly nymphs per *Serangium* adult. These data suggest that *Serangium* may have the potential to control whitefly at moderate to high levels.

Where parasitoid or predatory insects have been used for pest control at the field trial level, failures may occur from time to time. Factors that can influence the effectiveness of biological control agents include the specificity of agent (generalist or specialist), the type of agent (predator, parasitoid, or pathogen), the timing and number of releases, the method of release, synchrony of the natural enemy with the host, field conditions, and release rate. The pest-to-predator ratio is considered to be one of the major important factors (Stiling and Cornelissen, 2005). This study investigated the hypothesis that success in biological control of *B. tabaci* through the release of *S. parcesetosum* is much more certain if the ladybird beetle can be introduced when whitefly population is at a moderate level in greenhouses.

MATERYAL AND METHOD

Clean Plant Production

The tomato seedling cultivar" Tayfun" were planted singly in pots to produce robust plants for infestation with whitefly after 4-7 weeks.

Whitefly Production

Two cheese-cloth-covered cages approximately 110×50×80 cm were accommodated in a greenhouse. Fifteen cotton plants were caged every week and they were moved to a constant temperature room (27°C, 70% RH, 16 h photoperiod) and placed near the plants infested with whitefly, *B. tabaci*.

Serangium Parcesetosum Production

Ladybirds'adults were reared according to Yigit (1992). Every week 10 potted cotton plants, heavily infested by whitefly were introduced into a cage. The cages were kept in a room (25 °C, 70% RH, 16 h photoperiod). Ten to fifteen adults of *S. parcesetosum* were released into the cage.

Greenhouse Experiment

The effectiveness of *S. parcesetosum* against the whitefly populations with moderate and high density on greenhouse-grown tomato was evaluated in the Alata Horticultural Research Institute, in the spring of 2015 and 2016. In the greenhouse, tomato cv. "Tayfun" were planted in the middle of February with 360 tomato seedlings in 2015 and 2016. At the same date, sixteen exclusion cages (3×2.7×2 m), each of covering 20 tomato plants were placed in a greenhouse. When tomato plants reached the 6-leaf period, a high whitefly population was established by inoculating each cage with100 *B.tabaci* adults weekly to 8 cages for 3 weeks and a moderate whitefly population was established inoculating each cage with 50 adults *B. tabaci* weekly for the remaining 8 cages for 3 weeks. After this whitefly inoculation period, whitefly population was monitored weekly by sampling two leaves per plant of the selected 5 plants per cage from 4 April 2015 to 11 June 2015 and from 11 April 2016 to 13 June 2016.

Immature stages of whitefly on a 5 cm^2 leaf area were counted under a dissecting microscope. According to the whitefly densities and the number of adult whiteflies released at the beginning, the cages were divided into two groups, 8 of which had high whitefly density and the other 8 had moderate whitefly density. After determining mean whitefly density, four cages of each density (moderate, high) received a single release of *S. parcesetosum* two adults per plant (a total of 40 adults per cage) on 21 May 2015 and 25 April 2016. The remaining 4 cages of each density were considered untreated control. After the first release of the predator, the abundance of *S. parcesetosum* larvae and adults were recorded by visual inspections selected 5 plants per cage before taking the leaves to count *B. tabaci*. Mean whitefly densities per 5 cm^2 leaf area among two whitefly densities (moderate, high) and 2 *S. parcesetosum* release treatments (released, unreleased) were compared using a repeated measure (ANOVA), with the sample date as the repeated measure.

Data loggers (HOBO, Onset Computer, Bourne, MA, USA) were employed to track the temperature and relative humidity during the experiment. In 2015, the mean 10 days interval temperature and relative humidity during the experiment ranged, respectively from 22.1°C, 67.8% on 9 April to 30.8°C, 73.3% on 18 June. In 2016, the mean 10 days interval temperature and relative humidity during the experiment ranged, respectively from 23.4°C, 53.2% on 11 April to 29.4°C, 62.4% on 13 June.

RESULT AND DISCUSSION

The influence of initial whitefly density on whitefly population growth rate was independent of the presence or absence of *S. parcesetosum* (P> 0:05 for the whitefly density x predator release interaction), demonstrating no significant differences in whitefly suppression from *S. parcesetosum* predation were observed between the two initial whitefly densities in both years (Table 1 and 2). Whitefly population growth rates was not significantly different between two initial whitefly densities (whitefly density x sample week interaction) in 2016 (Table 2). However, it varied significantly in 2015 (Table 1).

Due to the lack of a significant initial whitefly density x predator release interaction, the hypothesis that biological control of *B. tabaci* by *S. parcesetosum* should be more effective on moderate initial whitefly density compared to high initial whitefly density was not supported by this experiment. Whitefly density was reduced by *S. parcesetosum* in high and moderate initial whitefly density cages 2-3 weeks after releasing ladybirds because *Serangium* is voracious feeders (Figure 1 and 2).

Table 1. Results of repeated measures ANOVA conducted immature *B. tabaci* in greenhouse experiment in 2015.
Çizelge 1. Domates serasında 2015 yılında Beyazsinek, B. tabaci'nin ergin öncesi dönemleri üzerinde yürütülen denemenin VARYANS analiz sonuçları.

Effect	**df**	**F**	**P**
Whitefly density	1,12	0,389	0,545
Predatory release	1,12	8,334	<0,014
Whitefly density x predator release	1,12	0,489	0,498
Sample week	10,120	20,334	<0,000
Predator release x sample week	10,120	6.293	<0.000
Whitefly density x sample week	10,120	2.653	<0.006
Whitefly density x predator release x sample week	10,120	1.565	0.125

Table 2. Results of repeated measures ANOVA conducted immature *B. tabaci* in greenhouse experiment in 2016.
Çizelge 2. Domates serasında 2016 yılında Beyazsinek, B. tabaci'nin ergin öncesi dönemleri üzerinde yürütülen denemenin VARYANS analiz sonuçları.

Effect	df	F	P
Whitefly density	1,12	10.493	<0.007
Predatory release	1,12	16,650	<0.002
Whitefly density x predator release	1,12	0.042	0.841
Sample week	9,108	7.627	<0.000
Predator release x sample week	9,108	5.503	<0.000
Whitefly density x sample week	9,108	0.416	0.924
Whitefly density x predator release x sample week	9,108	0.716	0.693

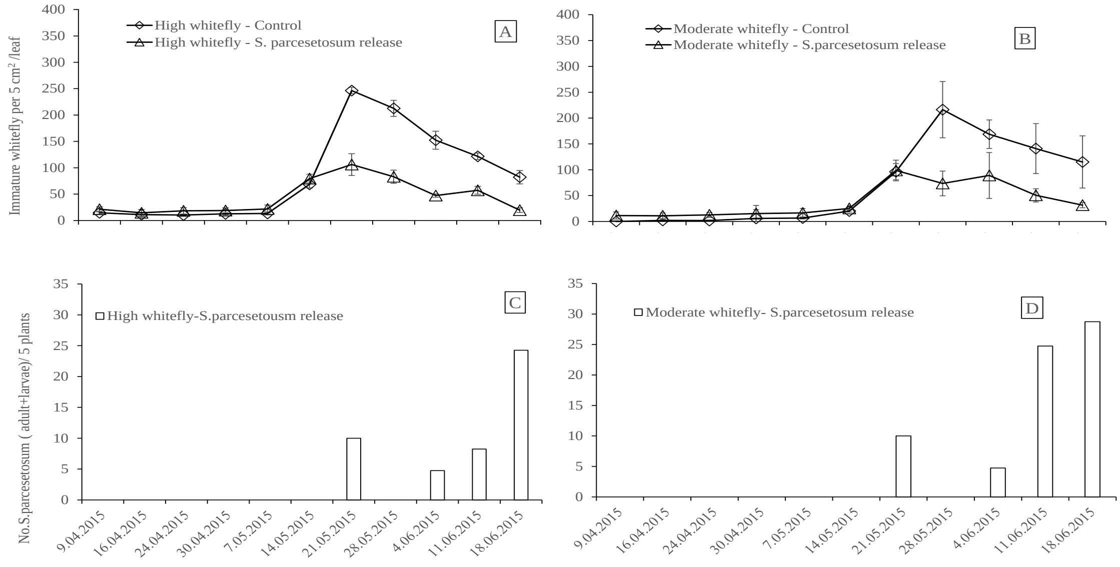

Figure 1: The influences of initial whitefly density and *S. parcesetosum* releases on *B. tabaci* population dynamics. Mean (±) numbers of *Bemisia tabaci* larvae and pupae per 5 cm² of leaf area in cages with and without releases of *S. parcesetosum* in high (A) and moderate (B) initial whitefly densitiy in 2015 and mean numbers of *S. parcesetosum* adults and larvae per plant observed in 2.5 min visual search in high (C) and moderate (D) initial whitefly densitiy ladybird released cages in 2015.
Şekil 1. S. parcesetosum salımının Beyazsinek, B. tabaci populasyonu üzerine etkisi.
2015 yılında başlangıç beyazsinek yoğunluğu yüksek (A) ve orta (B) olan kafeslerde S. parcesetosum salınan ve salınmayan (kontrol) kafeslerde ortalama (±) Bemisia tabaci (Larva + pupa)/ 5 cm² /yaprak ve başlangıç beyazsinek yoğunluğu yüksek (C) ve orta (D) olan S. parcesetosum salınan kafeslerdeki avcı (ergin+larva) sayıları (adet/bitki /2,5 dakika gözle kontrol)

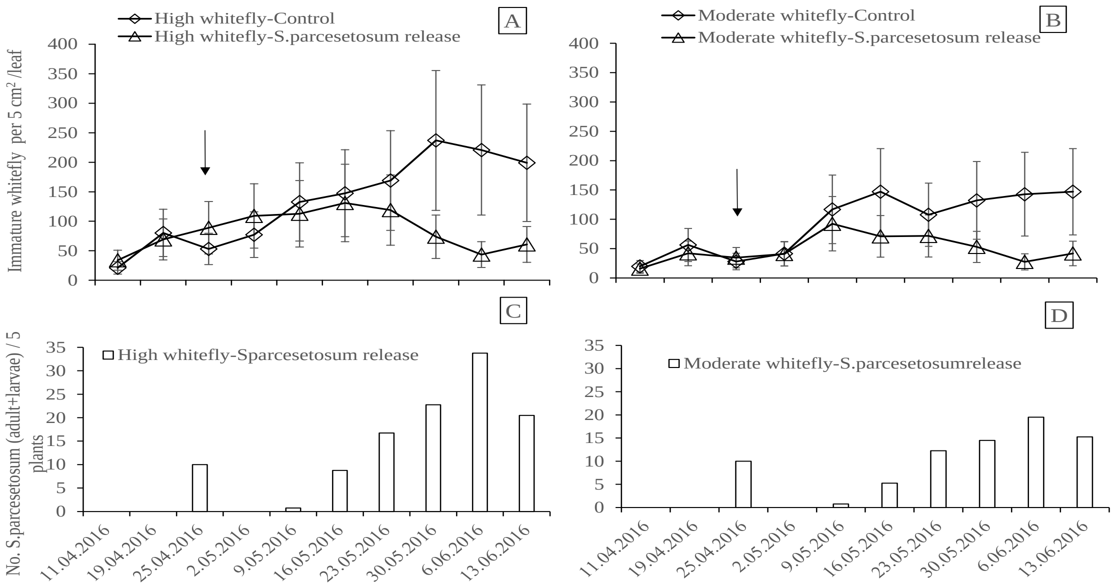

Figure 2: The influences of initial whitefly density and *S. parcesetosum* releases on *B. tabaci* population dynamics. Mean (±) numbers of *Bemisia tabaci* larvae and pupae per 5 cm^2 of leaf area in cages with and without releases of *S. parcesetosum* in high (A) and moderate (B) initial whitefly densitiy in 2016 and mean numbers of *S. parcesetosum* adults and larvae per plant observed in 2.5 min visual search in high (C) and moderate (D) initial whitefly densitiy ladybird released cages in 2016.

Şekil 2. S. parcesetosum salımının Beyazsinek, B. tabaci populasyonu üzerine etkisi.

2016 yılında başlangıç beyazsinek yoğunluğu yüksek (A) ve orta (B) olan kafeslerde S. parcesetosum salınan ve salınmayan (kontrol) kafeslerde ortalama (±) Bemisia tabaci (Larva + pupa)/ 5 cm^2 /yaprak ve başlangıç beyazsinek yoğunluğu yüksek (C) ve orta (D) olan S. parcesetosum salınan kafeslerdeki avcı (ergin+larva) sayıları (adet/bitki /2,5 dakika gözle kontrol)

During the experiment, copulating adults, larvae, and pupae were observed in both predator-releasing cages. These results indicated that *S. parcesetosum* can survive and reproduce on tomato plants, infested by *B. tabaci* in greenhouse production during the spring months in Turkey.

In the tomato–initial whitefly population–coccinellid predator system it is described in this paper, *B. tabaci* population suppression was obtained through the release of *S. parcesetosum* in both initial whitefly densities (Figure 1, 2). The results demonstrated that *S. parcesetosum* has increased its population with *B. tabaci* as prey and the whitefly populations decreased consequently, under plastic greenhouse tomato conditions (Figure 1, 2). It was found that *S. parcesetosum* developed successfully in plastic greenhouses where eggplant cultivated, infested by *B. tabaci* (Kutuk et al., 2008).

Tools of biocontrol-based IPM programs against *B. tabaci* is difficult in plastic houses (Stansly et al., 2004). However, attention in biological control proceeds to increase in the world (van der Blom, 2002) and usually, mirid (Heteroptera: Miridae) predators have been used in IPM programs. However, mirid predators are considered as a pest in the case of lack of their prey because they can feed on juice of tomato plants, causing necrotic rings on stems and flowers and punctures in fruits. These findings show that more biocontrol agents had to be introduced in plastic greenhouse tomato crop.

CONCLUSION

Serangium parcesetosum can be offered as an alternative solution to increase implementation of biologically *B. tabaci* management in greenhouses where tomato is cultivated in the Mediterranean Region of Turkey.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DECLARATION OF AUTHOR CONTRIBUTION

All authors performed the field experiments and counted all live whitefly individuals on the leaf samples in laboratory. All authors also read and approved the final manuscript.

REFERENCES

Albajes, R., & Alomar, O. (1999). Current and potential use of polyphagous predators. In R. Albajes, M. L. Gullino, J. C. van Lenteren, & Y. Elad (Eds.), *Integrated Pest and Disease Management in Greenhouse Crops* (pp. 265-275), Kluwer Academic, Dordrecht.

Bottrell, D. G., Barbosa, P., & Gould, F. (1998). Manipulating natural enemies by plant variety selection and modification: a realistic strategy?. *Annual Review of Entomology*, *43*, 347–67. https://doi.org/10.1146/annurev.ento.43.1.347

Karut, K. (2007). Host instar suitability of *Bemisia tabaci* (Genn.) (Hom.: Aleyrodidae) for the parasitoid *Eretmocerus mundus* (Hym.: Aphelinidae). *Journal of Pest Science*, *80*, 93-97. https://doi.org/10.1007/s10340-006-0157-2

Kutuk, H., Alaoglu, O., & Yigit, A. (2008). Evaluation of the lady beetle, *Serangium parcesetosum* for control of *Bemisiatabaci* on greenhouse eggplant in the Mediterranean region. *Biocontrol Science and Technology*, *18*, 675-683. https://doi.org/10.1080/09583150802213651

Legaspi, J. C., Legaspi, B. C., Meagher, R. L., & Ciomperlik, M. A. (1996). Evaluation of *Serangium parcesetosum* (Coleoptera: Coccinellidae) as a biological control agent of silverleaf whitefly (Homoptera: Aleyrodidae). *Environmental Entomology*, *25*, 1421-1427. https://doi.org/10.1093/ee/25.6.1421

Perring, T.M. (2001). The *Bemisia tabaci* species complex. *Crop Protection*, 20, 725-737. https://doi.org/10.1016/S0261-2194(01)00109-0

Sanchez, J. A., Martınez, J. I. & Lacasa, A. (2003). Distribuciongeografica, abundanciayplantashospedantes de mıridosdepredadores (Het.: Miridae). *Phytoma Espana, 154*, 54-55.

Stansly, P. A., Calvo, J., & Urbaneja, A. (2005). Release rates for control of *Bemisiatabaci* (Homoptera: Aleyrodidae) biotype "Q" with *Eretmocerus mundus* (Hymenoptera: Aphelinidae) in greenhouse tomato and pepper. *Biological Control, 35*, 124-137. https://doi.org/10.1016/j.biocontrol.2005.07.004

Stansly, P. A., Sanchez, P. A., Rodrıguez, J. M., Canizares, F., Nieto, A., Lopez, M. J., Fajardo, M., Suarez, V., & Urbaneja, A. (2004). Prospects for biological control of *Bemisia tabaci* (Homoptera: Aleyrodidae) in greenhouse tomatoes of Southern Spain. *Crop Protection*, *23*, 710–712. https://doi.org/10.1016/j.cropro.2003.11.016

Stiling, P., & Cornelissen, T. (2005). What makes a successful biological control agent? A meta-analysis of biological control agent performance. *Biological Control, 34*, 236-246. https://doi.org/10.1016/j.biocontrol.2005.02.017

Ulubilir, A., & Yabaş, C. (1996). Akdeniz Bölgesi'nde örtüaltında yetiştirilen sebzelerde görülen zararlı ve yararlı faunanın tespiti. *Türkiye Entomoloji Dergisi*, *20*, 217-228.

Ulubilir, A., Yaşarakıncı, N., & Keçeci, M. (1999). Örtüaltı sebze yetiştiriciliğinde entegre mücadele araştırma, uygulama ve eğitim projesi. Yıllık Raporlar, Adana Zirai Mücadele Araştırma Enstitüsü Adana, Türkiye (Proje No: BSA-EM-04/ Sonuç Raporu).

Van der Blom, J. (2002). La introduccio´n artificial de la fauna auxiliar encultivosagrıcolas. *Bol Sanid Veg Plagas, 28*, 109-120.

Van Lenteren, J. C., & Martin N. A. (1999). Biological control of whiteflies. In R. Albajes,M. L. Gullino, J. C. van Lenteren, & Y. Elad (Eds), *Integrated Pest and Disease Management in Greenhouse Crops* (pp. 202-216), Kluwer Academic, Dordrecht.

Yigit, A. (1992). Method for Culturing *Serangium parcesetosum* Sicard (Coleoptera: Coccinellidae) on *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae). *Zeitschrift fur Planzenkrankheiten und Planzenschutz*, *99*, 525-527.

Yoldaş, Z., Madanlar, N., & Gül, A. (1996, Eylül 24-28). *İzmir'de seralarda patlıcan zararlılarına karşı biyolojik savaş olanakları üzerinde araştırmalar* [Sözlü bildiri]. Türkiye III. Entomoloji Kongresi Bildirileri, Ankara Üniversitesi.

Yücel, S., Pala, H., Ulubilir, A., & Yiğit, A. (1995, Eylül 26-29). *Seralarda pamuk beyazsineği, Bemisia tabaci Genn.'ye karşı entomopatojen fungus, Verticillium lecanii (Zimm.) Viegas'nin etkinliğinin belirlenmesi* [Sözlü bildiri]. VII. Fitopatoloji Kongresi, Adana, Türkiye.