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Biological and Integrated Control of *Aphis gossypii* Glover (Hom., Aphididae) in Protected Cucumber and Melon. (*)

Introduction

Aphis gossypii Glover (Hom., Aphididae), the cotton aphid, is the main pest of protected cucurbits in Italy and northern Europe. The development of strains resistant to pirimicarb is a serious drawback to the use of beneficials and many studies are attempting to develop biological control strategies (van Steenis, 1992) by releasing natural enemies such as the parasitoid *Aphidius colemani* Viereck on cucumber (Burgio & Raboni, 1993) and melon (Ferrari & Burgio, 1993), *Aphidoletes aphidimyza* (Rond.) on cucumber and chrystanthemum (Chambers, 1993), or the two species together (Bennison, 1992; Bennison & Corless, 1993) on cucumber. Comparing the performances under small glasshouse of *A. colemani, Ephedrus cerasicola* Stary and *Lysiphlebus testaceipes* Cresson, van Steenis (1993a) concluded that *A. colemani* was the best parasitoid species to be used in biological control. By laboratory trials, van Steenis (1993b) calculated that the intrinsic rate of increase of *A. colemani* at 20 and 25°C was comparable to that of the cotton aphid, thus confirming it to be a promising candidate for the biological control of this pest. Guenaoui & Mahiout (1993) obtained good results by introducing a thelytokous strain of *Lysiphlebus fabarum* Marshall on paprika. A detailed study about biological control on cucumber in glasshouse by parasitoids was at last reported by van Steenis (1995).

The present study was carried out to determine the possibility of releasing *A. colemani* against *A. gossypii* in protected cucumber and melon crops. The study also examines the possibility of employing screens to prevent winged aphids from entering the plastic tunnel.

Materials and Methods

The trials were conducted on plastic tunnel-grown crops located in the

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Province of Bologna (northern Italy Po Valley). The aims were: I) to test the efficiency of the parasitoid *A.colemani* on cucumber and melon under glasshouse; II) to evaluate a type of preventive control of the aphid based on the cover of the tunnels by screens.

Samples were taken with a weekly basis from the end of April to mid-June for melon and to the end of August for cucumber, each sample containing from 200 to 500 leaves per tunnel. The parasitoids released were supplied by Bunting Biological Control Ltd (UK). The number of parasitoids released , the dates of releases and the kind of screens are shown in Table 1. Fenarimol treatments were used for mildew control and the predatory mite *Phytoseiulus persimilis* Athias-Henriot for controlling the red spider mite (*Tetranychus urticae* Koch).

Cucumber: release of *A. colemani* and use of screens to cover the tunnels

The trials were conducted on five tunnels of cucumber (cv. Darina) with a surface area of 300 m^2 each, evaluating the release of *A. colemani* and the use of different types of screens (Tab. 1 for the characteristics of the tunnels). Screens were installed in the tunnels on April 15 before the migration of the winged females from the primary hosts (*Hibiscus syriacus* L.) which, in the area under study, starts at the beginning of May (Ferrari & Nicoli, 1994).

Melon: release of *A. colemani*

The trials were conducted on melon (cv Harper) grown in three tunnels with a surface area of 250 m^2. The paratisoid was released in two tunnels. Release dates and the number of parasitoids released per tunnel are reported in Table 2.

Tab. 1 - Characteristics of the tunnels used for cucumber trials.

Tunnel	Release of *A. colemani*	*A. colemani* /m^2	Screen type	Insecticides/ Acaricides	Notes
1	May 18 May 25 June 1 June 8	0.8 1.3 1.5 1.5	no	/	Fenarimol (June 18, July 15) SBS (June 25) *P. persimilis* (June 9)
2	April 27 May 4 May 11 May 25	1.6 1.6 0.8 0.8	no	/	Fenarimol (June 18, July 15) *P. persimilis* (June 9)
3	/	/	70 mesh/cm^2	Heptenophos (May 19, June 15, July 26, August 13) Hexythiazox (June 18)	Fenarimol (June 18, July 15 July 26, *P. persimilis* (June 9)
4	/	/	150 mesh/cm^2	Heptenophos (May 19, June 18, August 13)	Fenarimol (June 18, July 26) *P. persimilis* (June 9) (June 9, June 29)
5	April 27 May 11 May 18 May 25	0.8 0.8 1.6 0.8	48 mesh/cm^2	/	Fenarimol (June 18, July 15) *P. persimilis* (June 9)

Tab. 2 - Characteristics of the tunnels used for melon trials.

Tunnel	Release of *A. colemani*	A. *colemani* /m²	Insecticides/
1	May 11 May 18	1 1	/
2	May 4 May 11 May 18	2 1 1	/

Results and discussion

Cucumber: release of *A. colemani* and use of screens to cover the tunnels

In tunnel 1, the parasitoid was not able to keep the aphid populations under control in such a way as to be economically viable even though a large number of mummies (Fig. 1) and wild predators (Fig. 2) was recorded. A lot of plants withered, especially at the edges of the tunnel, thus leading to considerable economic damage. A partial and momentary drop in aphid populations was reported following treatment with a wetting agent (SBS™ Serbios, Italy) at the end of June.

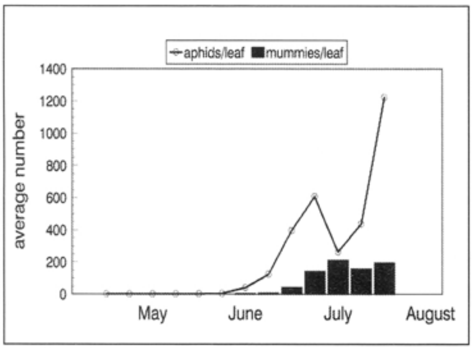

Fig. 1 - Trend of the populations of *A. gossypii* and mummies in tunnel 1 (cucumber)

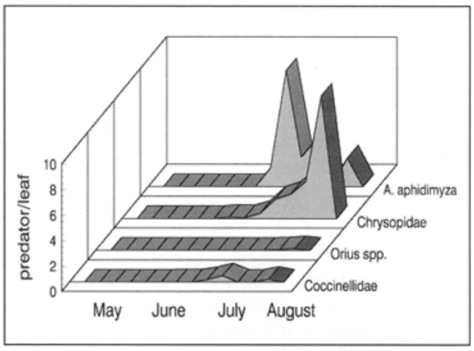

Fig. 2 - Trend of the populations of wild predators in tunnel 1 (cucumber)

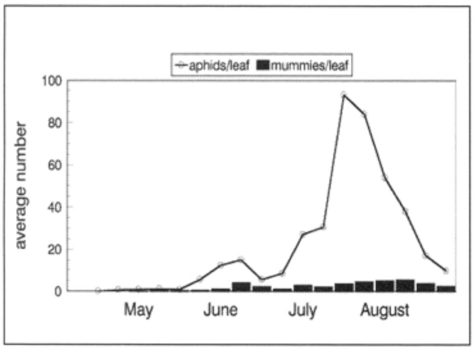

Fig. 3 - Trend of the populations of *A. gossypii* and mummies in tunnel 1 (cucumber)

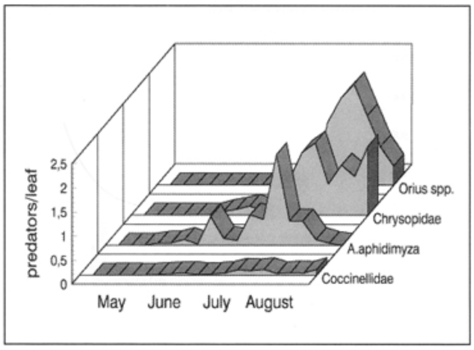

Fig. 4 - Trend of the populations of wild predators in tunnel 1 (cucumber)

Failure to control the aphid population in this tunnel may be ascribed to a number of reasons, namely: i) a more rapid development of *A. gossypii* populations caused by higher temperatures during the period in which the winged specimens appeared, ii) the ant-aphid mutualism.

The first winged specimens of *A. gossypii* appeared on 28th April in tunnel 2 and on 10th May in tunnel 1. The earlier appearance of the parasitoid in tunnel 2 probably favoured a more effective colonization of the aphid population. This may account for the good control of the aphid in tunnel 2 (Fig. 3) and for the important role played by wild predators in this control (Fig. 4). In fact, they were extremely effective in determining the decline of the aphid population beginning in the first week of July. The most important predator was *A.aphidimyza* Rondani because Coccinellids were recorded at a low level of population, *Orius* spp. are not specific predators of aphids; the activity of *Chrysoperla carnea* (Stephens) in the tunnels is overestimated because, in spite of a large number of larvae and eggs, on cucumber the predation is ineffective because locomotion of the larvae is inhibited by the the hairiness of the leaf (Scopes, 1969).

Figure 3 also shows the trend in the number of mummies in relation to aphid populations.

Infestations by *A. gossypii* were reported in the tunnels for all three types of screens (Figs. 5 and 6).

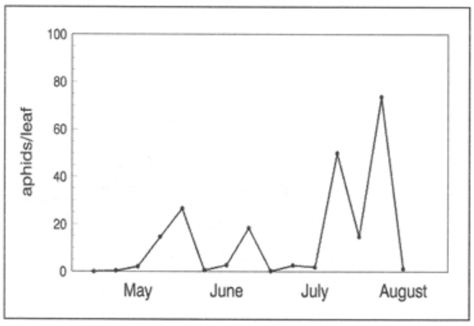

Fig. 5 - Populations of *A. gossypii* in tunnel 3 covered with screen (70 mesh/cm^2, cucumber).
See table 1 for the timing of chemical sprays.

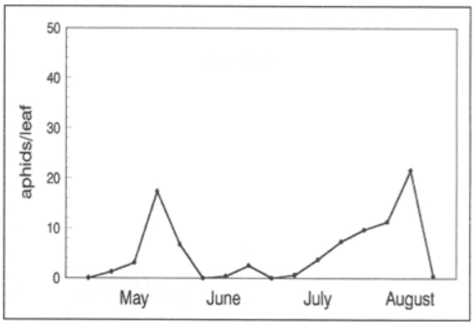

Fig. 6 - Populations of *A. gossypii* in tunnel 4 covered with screen (150 mesh/cm^2, cucumber).
See table 1 for the timing of chemical sprays.

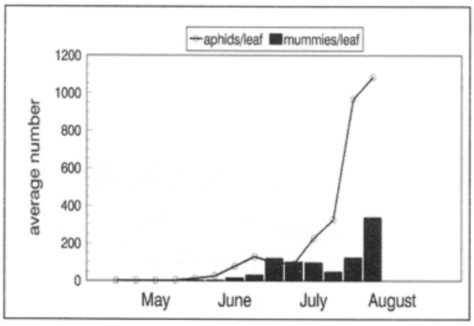

Fig. 7 - Populations of *A. gossypii* in tunnel 5 covered with screen (70 mesh/cm^2, cucumber). See table 1 for the timing of chemical sprays.

At least for the tests considered, it can be said that the preventive control by screens has failed. Two reasons may be given for this failure, namely either the inadequacy of the screen in preventing the winged specimens from entering or the possibility that parthenogenetic females may have overwintered inside the tunnels on weeds under the plastic mulch. This latter assumption may be borne out by the fact that infestation was already under way in mid-April, which in the considered area is early given that the first flights of the winged aphids from the primary host were observed at the beginning of May (Ferrari & Nicoli, 1994). Moreover, it may also be assumed that the ants played a major role in propagating the infestation by transferring the aphids from the outside to the inside of the tunnels or at least that they may have favoured the growth of the colonies. This assumption is supported by the fact that numerous ants of *Formica cinerea* Mayr and *F. cunicularia* Latr. were found on the plants infested by *A. gossypii*. Chemical control was made in two of the three tunnels for the screen tests (Figs. 5 and 6), while the *A. colemani* parasitoid was released in the other (Fig. 7). Tunnel 5 was screened in order to test the impact of the parasitoid on aphid populations in the absence of predators. In this tunnel, a fairly good control of the aphid population, as indicated by the high number of mummies reported, was observed for the greater part of the season (from mid-May to beginning of July), while a sudden increase in pest populations was reported at the end of July, attaining economically damaging levels towards the end of the crop growth cycle. This latter trend may be accounted for by the fact that the screens prevented wild predators from entering the tunnel.

Melon: releases of *A. colemani*

In both the melon tunnels, the number of mummies remained very low and the parasitoid did not prevent the growth of the aphid populations which reached and exceeded the damage threshold (Figs. 8 and 10). Probably, the growth habit of the plant and other intrinsic characteristics of the crop (leaves spreading out over the ground) may have caused a poorer performance of the parasitoid, thus affecting its foraging behavior. The absence or the very low populations of natural predators (Figs. 9 and 11) and of their simultaneous contribution to the control should also be noted as they are very important in limiting the growth of the aphid populations or at least in delaying it.

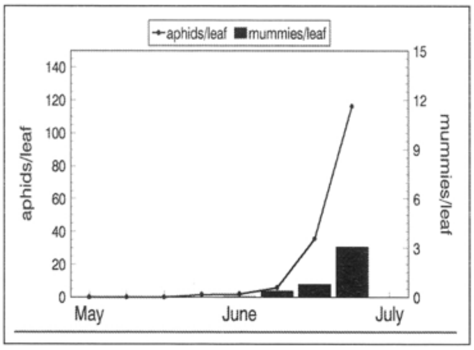

Fig. 8 - *A. gossypii* and mummies populations in tunnel 1 (melon)

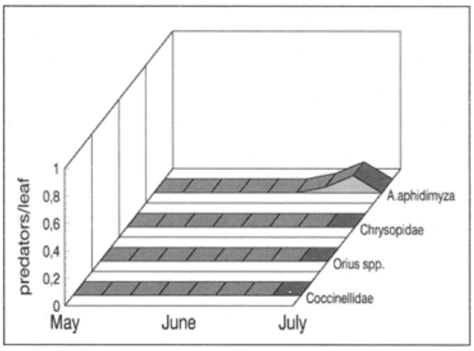

Fig. 9 - Population of wild predators in tunnel 1 (melon)

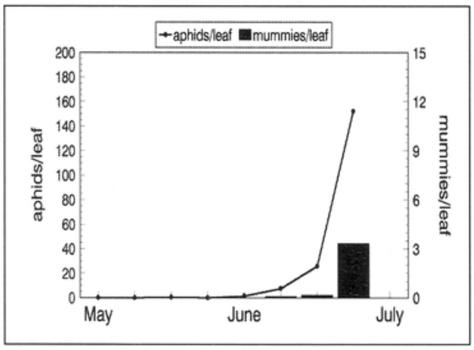

Fig. 10 - *A. gossypii* and mummies populations in tunnel 2 (melon)

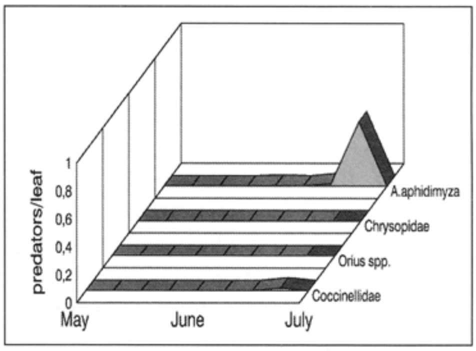

Fig. 11 - Populations of wild predators in tunnel 2 (melon)

In optimum conditions, *A. colemani* proved to reduce *A. gossypii* infestations on cucumber, reaching, in some cases, good population levels. On melon, the parasitoid did not show a sufficient parasitization rate, as indicated by the very low number of mummies recorded. The different response pattern of the parasitoid towards these two crops appeared to be ascribed to the different foraging behaviour arising from the different characteristics of the plants.

Favourable techniques of application of the parasitoid in Northern Italy seem to be: I) timely releases when aphid populations are very low; II) early development of the parasitoid population so as to be able to attack the aphid in optimal conditions (mild temperatures and low aphid populations). Under other conditions, despite a good impact on the *A. gossypii* population, *A. colemani* did not appear effective in limiting the pest at economically acceptable levels.

The use of banker plants (Bennison, 1992) or the method developed by Stary (1993) permit the parasitoid population to be established parasitizing aphid species which are not harmful to the crop before infestation begins, thus ensuring a better impact of the parasitoid on the aphid populations harmful to the crop and, consequently, a more effective control. Bennison (1992) also studied a combination of *A. colemani* and *A. aphidimyza* released through an open rearing method and van Steenis (1995) compared an open rearing method with repeated introductions of *A. colemani*. Differences in the climate, cultural practices, and presence and abundance of wild predators in northern Europe do not allow for a precise comparison with our experiments.

Moreover, the presence of a large number of hyperparasitoids emerged from mummies collected in the trial tunnels (mainly *Pachyneuron aphidis* Bouché) may limit the action of *A. colemani*. In our opinion the hyperparasitoids are responsible for the drop in parasitoid populations in the late season. Hyperparasitoids in cucumber glasshouse was observed by van Steenis (1995) in the Netherland, indicating that the failure of control of *A. gossypii* by *A. colemani* during the summer could be partly caused by the high temperatures.

Natural predators play a very important role in controlling aphid population on cucumber; *A. aphidimyza* appeared to be the most abundant; its activity on cucumber begin in June, reaching the maximum activity when the aphid population was at its peak. On melon, the role of these predators is negligible due to the short growth cycle of this crop which ends in June before the predators reach their peak.

The use of screens appeared to be ineffective to prevent the aphid colonization. Ants may play an active role both in spreading the infestation and in protecting the aphids. In melon crops, on the other hand, the use of screens cannot be adopted as it would prevent the entrance of pollinators.

The possible use of other Braconidae, such as *Lysiphlebus* spp., which are attacked by ants to a lesser extent (Stary, 1970; Vinson & Scarborough, 1991; Völkl, 1992; Völkl & Mackauer, 1992), are worth investigating.

KEY WORDS: *Aphis gossypii*, cucumber, *Aphidius colemani*, biological control.

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SUMMARY

Biological and integrated control tests were conducted for the control of *Aphis gossypii* Glover in protected cucumber and melon crops. The *Aphidius colemani* Viereck parasitoid was found to be partially effective on cucumber but its performance was very poor on melon. The optimum conditions and the limits of parasitoid use were examined. Wild predators were found to be essential for full aphid control in cucumber while the screens used proved to be insufficient to prevent *A.gossypii* infestations.

Lotta biologica e integrata contro *Aphis gossypii* Glover (Homoptera: Aphididae) su cetriolo e melone in coltura protetta.

RIASSUNTO

Sono state condotte prove di lotta biologica-integrata per il controllo di *Aphis gossypii* Glover su cetriolo e melone in coltura protetta. Il parassitoide *Aphidius colemani* Viereck, nelle condizioni da noi studiate, ha mostrato essere parzialmente efficace su cocomero, mentre ha esibito maggiori difficoltà nel controllo dell'afide su melone. Nel lavoro sono discusse e valutate le condizioni ottimali di utilizzo del parassitoide. Il ruolo dei predatori selvatici è stato essenziale nel controllo dell'afide su cetriolo, mentre le reti anti-insetto usate per prevenire l'infestazione, hanno mostrato essere inefficaci.

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