JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 44, No. 2 (2004)

THE USE OF *APHIDIUS COLEMANI* AND *APHIDOLETES APHIDIMYZA* TO CONTROL DAMSON-HOP APHID (*PHORODON HUMULI* SCHRANK) ON HOP

Ewa Solarska

Institute of Soil Science and Plant Cultivation
Czartoryskich 8, 24-100 Puławy, Poland
e-mail: esolar@iung.pulawy.pl

Accepted: May 24, 2004

Abstract: The studies on biological control of damson-hop aphid (*Phorodon humuli* Schrank) on Marynka cultivar, using *Aphidius colemani* and *Aphidoletes aphidimyza,* were carried out in the hop-garden localised within Hop Experimental Station at Jastków over the years 1998–2000. The efficacy of *Aphidius colemani* ranged from 5% to 65% and was found sufficient to control damson-hop aphid in the period before flowering i.e. to the middle of July, but it was not sufficient later. The efficacy of *Aphidoletes aphidimyza* ranged from 50% to above 90% and it was sufficient in one of the examined vegetation seasons. High air temperature and lack of rainfall reduced efficacy of both species, but especially that of *Aphidius colemani.*

Key words: hops, damson-hop aphid, biological control, *Aphidius colemani, Aphidoletes aphidimyza*

INTRODUCTION

Hop is one of the crops, cultivation of which requires the most frequent and systematic chemical control of pests as sometimes synthetic pesticides need to be applied up to 10 times in one vegetation season. Damson-hop aphid belongs to a group of the most common pests that infest hop plants every year and, if not controlled, it may cause considerable qualitative and quantitative crop losses. The assortment of aphicides to control damson-hop aphid is limited, and due to quick increase of resistance of chemically-treated insect populations their efficacy is still decreasing (Herdeg 1982; Denholm et al. 1998). At the same time greater number of plant protection treatments and greater amount of active ingredient used make both soil and ground water more threatened by a contamination (Fritz 1993). Synthetic, non-selective pesticides, especially pyrethroids not only kill hop pests but also destroy their biological enemies (Boczek and Lipa 1987).

The main objective of the studies carried out in the years 1998–1999 was to examine the possibilities to control damson-hop aphid by introducing its natural enemies: *Aphidius colemani* and *Aphidoletes aphidimyza*.

MATERIALS AND METHODS

The experiment curried out in a hop garden planted with Marynka variety at the Institute of Soil Science and Plant Cultivation Experimental Station Jastków near Lublin included 3 treatments with 3 replications. Each treatment consisted of 5 subsequent plants in a row, and individual treatment plots were separated from each other by 5 other plants in a row and 2 plant belts between rows. The parasitoid and predator were supplied by Koppert Biological System (The Netherlands). Successive dates of release were defined on the base of earlier efficacy tests. The following treatments were included:

- treatment I – There were three dates of release of *A. colemani* aphid mummies on each hop plant in 1998 (3.07;17.07;7.08) and two dates in 1999 (18.06;16.07). In 1998 7, 17 and 17 *A. colemani* aphid mummies were released on the particular dates and 17 and 17 such mummies were released on both dates in 1999.
- treatment II – On the same dates as for *A. colemani,* 12 ,17 and 17 pupae of *A. aphidimyza* were released on each hop plant in 1998 and 17 each on both dates in 1999.
- control I – There was chemical control with standard aphicide- Confidor used at 0.018% concentration only once per season.
- control II – There was no chemical or biological control against aphids.

All necessary agronomic treatments, including fungicide applications took place in every combination. *A. colemani* and *A. aphidimyza* were introduced, when the mean number of nymphs ranged between 20 and 40 individuals per 1 leaf, in rolled and stapled leaves, and placed at the middle of each plant bine. The weekly observations were made from the tractor-mounted platform to define natural enemies activity. The number of aphids on leaves collected from plants was determined under the binocular. Average numbers of aphids on leaves were defined prior to the treatment and 2, 7, 14, 21, 28 and 35 days after each treatment. Aphids were counted on 5 plants per treatment with 8 leaves examined per plant. The effectiveness of natural enemies activity was calculated according to the Abbot formula:

$$Ef = \left(\frac{K1 \times A2}{K2 \times A1} \right) \times 100$$

A1-initial number of aphids prior to treatment; A2-final number of aphids after treatment;

K1-initial number of aphids in control (no treatment); K2-final number of aphids in control.

The efficacy was estimated according to the following scale: 99.2%–100% very good effectiveness; 96.8%–99.1% good effectiveness; 90.0%–96.7% low effectiveness; 68.0%–89.9% very low effectiveness.

Treatments were compared statistically using Tukey's test.

Temperature and precipitation were recorded in weather station localised near the hop-garden.

RESULTS

In 1998 the population of *P. humuli* was very large and developed from the end of June until the end of July, remaining at the level of above 100 individuals per leaf for 3 weeks (Fig. 1). Effectiveness of *A. colemani* introduced at first date was at the level of about 50% and after the release on second date it ranged from 52% to 65%. Effectiveness of *A. aphidimyza* ranged between 60% and 67% for the first, and between 60% and above 70% for the second release. Only after the biocontrol agents had been released for the third time they gave 100% control and their effectiveness was nearly equal to that of a synthetic pesticide. However, very high natural mortality of aphids was noted after the third release of the biocontrol agents.

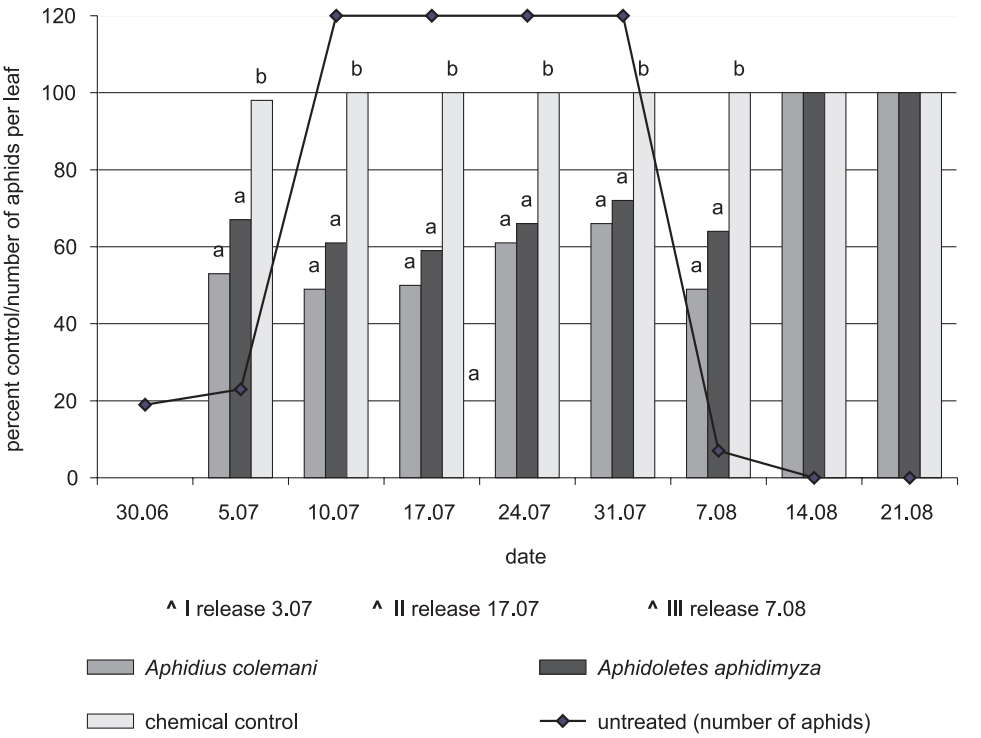

Fig. 1. Efficacy of *Aphidoletes aphidimyza* and *Aphidius colemani* in control of damson-hop aphid (*Phorodon humuli* Schrank) on hop in1998

In 1999 the aphid population reached the highest level in the middle of June i.e. mean 40 individuals per 1 leaf, but towards the end of August, it was at a very low level. Both biocontrol agents introduced for the first time proved not to be effective enough through the next 3 decades (Fig. 2).

It may be assumed that weather conditions in I and II decade of July, especially high air temperature and lack of rainfall did not favour development of *A. colemani* (Fig. 3). Higher temperatures and increased rainfall in the III decade in July as well as release of the next part of biological agents improved the effectiveness, initially

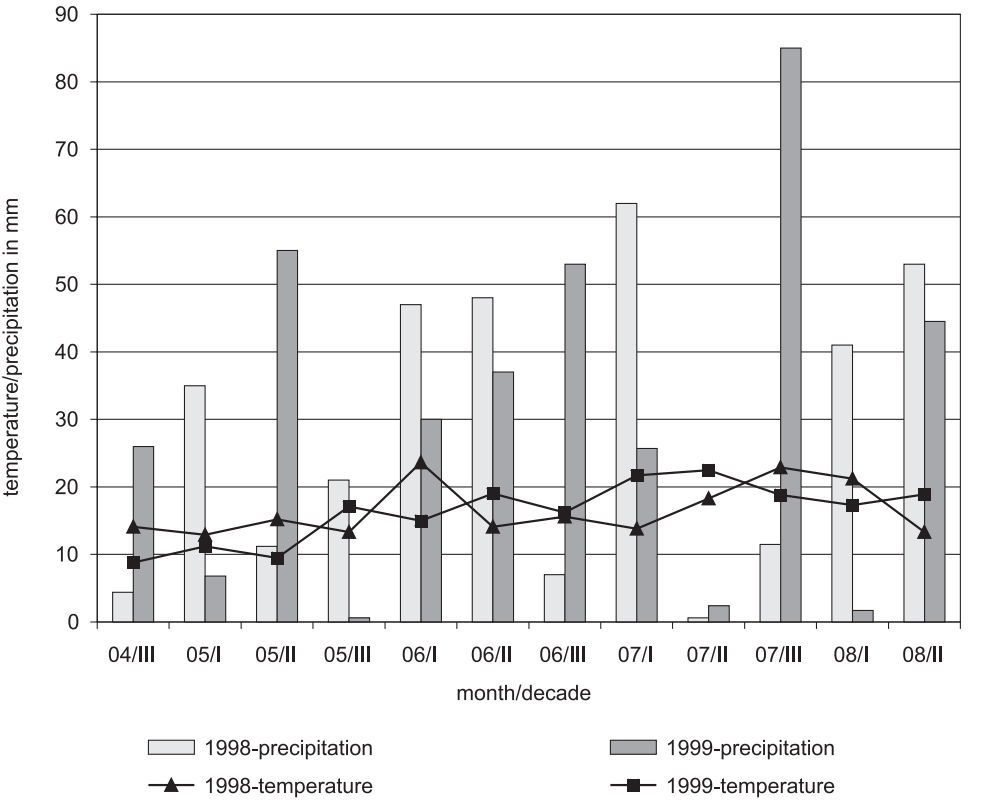

Fig. 2. Efficacy of *Aphidoletes aphidimyza* and *Aphidius colemani* in control of damson-hop aphid (*Phorodon humuli* Schrank) on hop in 1999

to 60%–70% in the case of *A. colemani* and to 93% and greater in the case of *A. aphidimyza*. The aphicidal efficacy of *A. aphidimyza* was better than that of *A. colemani* and it was significantly greater for *A. aphidimyza* during the season when aphid population was low. During both vegetation seasons, efficacy of biocontrol agents was significantly lower than that of chemical control (Tab. 1).

Table 1. Efficacy of *Aphidius colemani* and *Aphidoletes aphidimyza* in control of hop aphid

Treatment	% control	
	1998	1999
Aphidius colemani	66.7 a	62.7 a
Aphidoletes aphidimyza	73.9 a	81.4 b
Chemical standard	99.6 b	97.1 c
LSD (0.05)	12.45	14.8

Means followed by the same letter within column are not significantly different at $\alpha = 0.05$

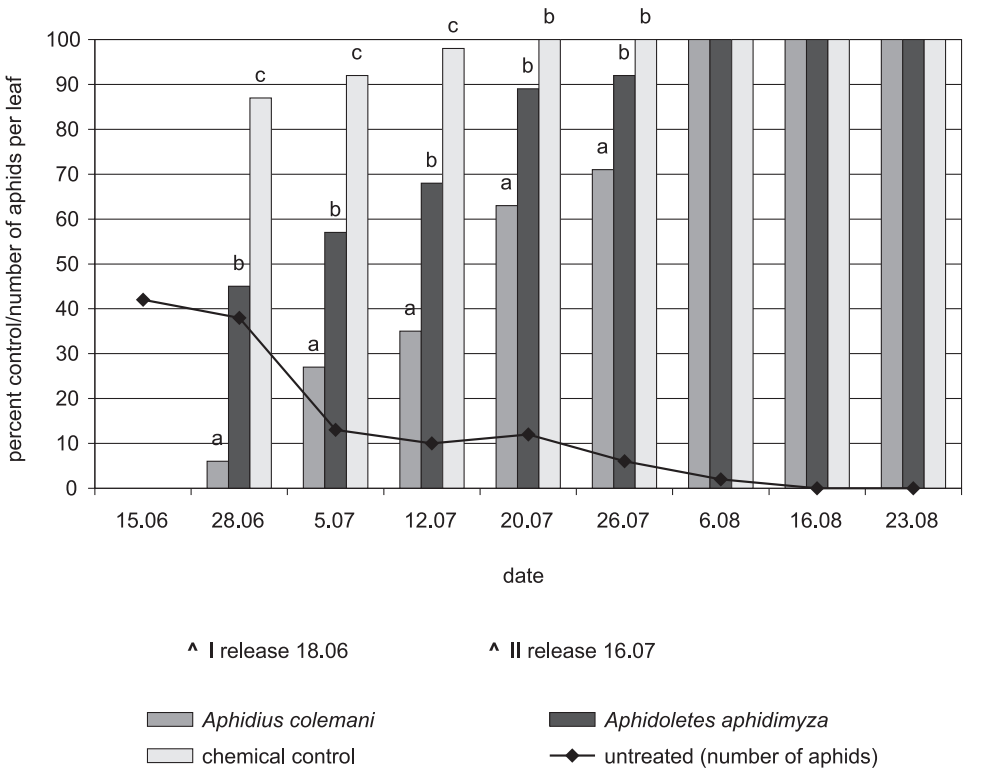

Fig. 3. Decade sums of precipitation and average decade air temperature at Jastków in 1998 and 1999

DISCUSSION

Predatory and parasitic insects naturally present on hop plants rarely reach high enough density to be able to decrease the number of aphids to the level at which no reduction of plant quality is observed (Cranham 1982). Aphidophagous insects should be then laboratory reproduced, and introduced into hop gardens at numbers allowing satisfactory control of the pest. However, some species developed in this way are less effective in controlling aphids than populations of the same species occurring in natural conditions (Campbell 1990). Promising results in control of damson-hop aphid were obtained by release of *Cocinnella septempunctata* on hop plants. The genus is widespread in the wild (Engelhard 1996; Vostrel and Vesely 1995).

There have been some attempts to replace chemical control by introducing biological predators against damson-hop aphid but so far they have not been satisfactory enough. In Great Britain reduction of nephospholane rates to control damson-hop aphid allowed to obtain high effectiveness of *Anthocoris nemoralis* and *Anthocoris nemorum* (Cranham 1982).

In Germany release of *A. colemani* and *Hippodamia convergens* led to reduction of *Phorodon humuli* population. Three-fold release of *Orius majusculus* (10 individuals per 1 unit) during a vegetation season considerably reduced exules population of *P. humuli* and the effectiveness of their feeding was equally high on plantations run on traditional and low-trellis constructions (Engelhard 1996).

The studies proved that the effectiveness of biological agents at 50% – 70% control of aphids can be easily obtained and it is sufficient at early stages of the pest population development i.e. before flowering. However, at later stages i.e. during flowering no satisfactory control can be obtained. In 1999 high effectiveness achieved during flowering and later was a consequence of high natural mortality of aphids. The studies on biological control of damson-hop aphid need to be continued.

REFERENCES

Boczek J., Lipa J.J. 1987. Biologiczne metody walki ze szkodnikami. PWN Warszawa, 593 pp.

Campbell C.A.M. 1990. Introduced predators for biological control of hop pests. The BCPC Conferences – Pest and Diseases 4B-4: 333–336.

Cranham J.E. 1982. Integrated control of damson-hop aphid *Phorodon humuli* on English hops. Agric. Environm., 7: 63–71.

Denholm I., Barber M., Tatchell M. 1998. Insecticide resistance detected in lettuce aphid. Materials from Internet: http://www.iacr.ac.uk/res/depts/bec/research/insect/ tmatt.html

Engelhard B. 1996. Pflanzenschutz im Hopfenbau 1995. Bayerische Landesanstalt für Bodenkultur und Pflanzenbau und Deutsche Gesellschaft für Hopfenforschung Hans-Pfülf-Institut. Jahresbericht, p. 77.

Fritz R. 1993. Pflanzenschutzmittel in der Atmosphäre. Pflanzens.-Nachri.Bayer 93/3, 46 (64): 229–264.

Herdeg G. 1982. Untersuchungen zur Insektizidresistenz der Hopfenblattlaus (*Phorodon humuli* Schrank) im Hopfenanbaugebiet Tettnang. Z. PflKrank. PflSchutz., 89 (8/9): 468–474.

Vosřtel J., Vesely F. 1995. Ochrana chmele proti škodlivým činitelum. Chmelařsky Institut S.R.O. 70. Vyroči Chmelařského Vyzkumu v České Republice, 1925–1995: 47–60.

POLISH SUMMARY

WYKORZYSTANIE *APHIDIUS COLEMANI* I *APHIDOLETES APHIDIMYZA* DO ZWALCZANIA MSZYCY ŚLIWOWO-CHMIELOWEJ (*PHORODON HUMULI* SCHRANK) NA CHMIELU

W latach 1998–2000 w Zakładzie Doświadczalnym Instytutu Uprawy Nawożenia i Gleboznawstwa w Jastkowie przeprowadzono badania nad biologicznym zwalczaniem mszycy śliwowo-chmielowej (*Phorodon humuli* Schrank) na odmianie chmielu Marynka wykorzystując wrogów naturalnych szkodnika: *Aphidius colemani* i *Aphidoletes aphidimyza*. Skuteczność *Aphidius colemani* wynosiła od 5% do 65% i tylko w okresie przed kwitnieniem chmielu była ona na poziomie wystarczającym do ograniczenia szkodnika, natomiast później była ona niezadowalająca. Skuteczność *Aphidoletes aphidimyza* wahała się od 50% do powyżej 90% i była bardzo dobra w jednym z sezonów wegetacji. Wysoka temperatura powietrza i brak opadów ograniczały efektywność obydwu gatunków, a szczególnie *Aphidius colemani*.