An attempt to prevent mating of the mullein bug
Campylomma verbasci (Heteroptera: Miridae) in Dutch apple orchards

Herman H.M. Helsen & Leo H.M. Blommers

Plant Research International, Praktijkonderzoek Plant en Omgeving, Sectie Fruit, PO Box 200, 6670 AE Zetten, The Netherlands (h.helsen@ppo.dlo.nl)

The mullein bug Campylomma verbasci (Meyer-Dür) was first recognised as a pest of apple in the Netherlands in 1993. During the following years, damage by this mirid species increased to a considerable level in the southern provinces and in adjacent regions in Belgium (Blommers, 1994; Stigter, 1995). Until then C. verbasci was considered to be a beneficial species in European orchards as it feeds on spider mites and aphids (Collyer, 1953a,b; Fauvel, 1974; Niemczyk, 1978). Like in Canada and the northern United States, were this species is a serious orchard pest since long (Smith, 1991; Reding & Beers, 1995), the feeding of the young nymphs on ovaries of apple flowers causes pit-like craters in fruits, especially on the variety Golden Delicious.

Campylomma verbasci overwinters as an egg in the bark of apple and other species of Rosaceae. Eggs hatch around blooming time of apple, and the pale green nymphs pass through five nymphal stages. Most adults migrate away from the winter hosts in June or July and produce one or more summer generations on herbaceous plants. Mullein (Verbascum spp.) seems to be the principal host, but in the Netherlands nymphs of C. verbasci were also found on hollyhock (Althaea rosea (L.)) and on unsprayed potato (Solanum tuberosum L.) plants. In fall, adults migrate back to woody hosts, were egg laying takes place (McMullen & Jong, 1970; Blommers, 1994; Stigter, 1995).

Identification of the sex pheromone of C. verbasci (Smith et al., 1991) provided the opportunity for developing a mating disruption technique. McBrien et al. (1997) were successful in suppressing populations of mullein bug in Canadian apple orchards by permeating synthetic sex pheromone throughout late summer and fall, using 1000 Phero Tech pheromone dispensers per hectare. This paper describes the application of this technique in four apple orchards in The Netherlands during summer and fall of 1997, and its evaluation in the next spring. Furthermore, some observations on the phenology of the mullein bug were done.

MATERIAL AND METHODS

Study sites

Mating disruption experiments were carried out in three commercial and one experimental orchard, all located in the province of Limburg in the south of The Netherlands (Table 1). The orchards consisted of modern high-density spindle bush plantations, planted predominantly with cv. Golden Delicious, and had a history of fruit damage caused by C. verbasci. In each of the orchards an area of 1 ha (0.45 ha in the orchard at Baarlo) was treated with pheromone dispensers. On two sides of this treated area, adjacent plots were left untreated.
Table 1. Tree spacing, density and surface of treated and control plots in four apple orchards used as study sites in Limburg, the Netherlands

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Spacing (m)</th>
<th>Trees/ha</th>
<th>Treated area (ha)</th>
<th>Control area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linne</td>
<td>3.5 x 1.5</td>
<td>1904</td>
<td>1</td>
<td>2 x 0.5 ha</td>
</tr>
<tr>
<td>Kessel</td>
<td>3.0 x 1.5</td>
<td>2222</td>
<td>1</td>
<td>2 x 1.5 ha</td>
</tr>
<tr>
<td>Baarlo</td>
<td>3.0 x 1.25</td>
<td>2667</td>
<td>0.45</td>
<td>2 x 0.22 ha</td>
</tr>
<tr>
<td>Meterik (exp.)</td>
<td>3.1 x 1.3</td>
<td>2481</td>
<td>1</td>
<td>2 x 0.6 ha</td>
</tr>
</tbody>
</table>

Observations on mullein were done on a patch of plants near Horst (Limburg). This patch extended over a few hundred meters on the shoulder of a highway, and was the only place where we found mullein in the region. Additional observations were done in a 0.6 ha apple plantation (Horst) that was situated 300 m from the mullein plants.

Pheromone mating disruption

Pheromone dispensers were provided by Phero Tech Inc (Delta, BC, Canada) and consisted of urethane pheromone-impregnated polymer cores inside polyvinylchloride (PVC) sleeves containing a 16:1 blend of butyl butyrate and 2(E)-crotyl butyrate (cf. McBrien et al., 1996). On 23 and 24 July 1997 1000 dispensers per ha were hung singly on tree poles at a height of approximately 1.70 m, in the upper third of the tree and on the north side to minimise exposure to direct sunlight.

Pheromone-baited traps

At the experimental orchard at Meterik three types of pheromone traps were compared in threefold: a transparent delta trap (Plant Research International, Wageningen, The Netherlands), an Isagro trap (Isagro S.p.a., Italy) and a Phero Tech open wing trap (cf. McBrien et al., 1994a). All traps were equipped with Phero Tech dispensers, and installed on 6 June. The position of the traps was changed weekly.

In each of the commercial orchards 6 to 10 transparent delta-type pheromone traps with Phero Tech dispensers were employed, two or three in the pheromone treated area and the others in the untreated plots. Traps were installed on the same date as the pheromone mating disruption. Three additional delta-type pheromone traps were installed on 7 July in the orchard at Horst. Traps were checked weekly at Meterik and Horst, and every two weeks in the other orchards.

Tapping samples

In 1997 the phenology of *C. verbasci* was observed on apple and mullein using tapping samples. Branches or plants were beaten above a grey plastic tray (30 x 55 cm) in which the young *C. verbasci* nymphs could be easily recognised and collected. In May 1998 limb-tap samples were taken to determine the density of the offspring of *C. verbasci* in pheromone treated and control plots in all apple orchards.

Use of insecticides

No insecticides were applied during the experiment in 1997. Before bloom in 1998, all orchards received a treatment with fenoxycarb against caterpillars. In Meterik and Linne pirimicarb was applied against aphids. Both insecticides are not known to have an effect on *C. verbasci*. In Baarlo and Kessel, phosphalene was sprayed in April, well before the eggs of *C. verbasci* hatched. In all cases, pheromone treated and control plots were treated identically.

RESULTS AND DISCUSSION

Comparison of pheromone trap types

At Meterik, a total of 55 male bugs were trapped in six traps between 6 June and 16 October. These low trap catch numbers did not enable us to compare the efficiency of the different trap types. Weekly catches from all traps in the untreated area were pooled to generate a flight curve for this orchard.
Phenology in 1997

On 20 May the scarce nymphs in limb-tap samples from apple at Meterik ranged from second to fifth instar. Ten days later of 15 collected nymphs (from 300 branches tapped) seven nymphs were in the fourth and eight were in the fifth instar. The majority of the bugs must have become adult in the first half of June, although the first adults may have been missed in the samples in May. The numbers of first generation adults in pheromone traps in this orchard were extremely low as well (Fig. 1). In six traps only two males were caught in the week preceding 13 June.

On 30 July older stage nymphs and young adults were present in the tapping samples from mullein (Fig. 2). During August the relative numbers of nymphs decreased gradually, and from 4 September onwards no more *C. verbasci* were found on the mullein plants. By then these plants were completely parched. Analogous to the appearance of the adult bugs on mullein, males appeared in the pheromone traps at Meterik between 7 and 14 August (Fig. 1). In the orchards at Linne, Kessel and Baarlo no males were trapped before 7 August. Only at Horst, at short distance from the mullein plants, males were caught between 30 July and 7 August. Trap catches continued till the beginning of October.

These observations indicate that *C. verbasci* had only one generation on its summerhost. An experiment in 1994 showed that adults collected from mullein on 3 August produced another summer generation when they were kept in a rearing cabinet on potato plants at 20°C (H. Helsen, unpublished). In the interior of British Columbia *C. verbasci* can complete three generations, of
which two take place on the summer host (McBrien et al., 1994). One gets a better understanding of the phenology, and of the importance of a third generation, if the development time in day-degrees (DD) is taken into consideration (cf. McBrien et al., 1994). Based on the estimated development time of summer-generation *C. verbasci* on eggplant (Smith & Borden, 1991), *C. verbasci* should complete one summer generation on mullein in ≈400 DD_{10°}. For a rough estimate, the assumption that growth rates on the two hosts are similar is permissible. Considering 30 July (554 DD_{10°} after 1 January) as the first appearance of the second-generation adults (Fig. 2), yields 31 May (554 – 400 = 154 DD_{10°}) as the estimated date of appearance of the first-generation adults. This fits with our observations on first-generation nymphs. Any third generation *C. verbasci* would become adult after 15 September (554 + 400 ≈ 954 DD_{10°}). At this time *C. verbasci* was completely absent from mullein, and the trap catch numbers in the orchards were decreasing, showing the improbability of a significant third generation in 1997.

**Evaluation of pheromone treatment**

Numbers of mullein bugs trapped in control plots in autumn varied between nine males per trap in Meterik and 71 males in Kessel (Table 2). Relative to the control plots, the number of males captured in the pheromone treated area were reduced by 88-100% indicating a disorientation of males to point sources of synthetic pheromone.

The numbers of nymphs in spring, as assessed by limb-tap samples, are shown in Table 3. Because broad-spectrum insecticide applications were planned in Linne and Kessel, these orchards were sampled on 15 May, four or five days before the other orchards were sampled. As the first and second instar nymphs, that were present at the time, might be difficult to dislodge, the early sampling date partially explains the low numbers in these orchards.

There are no differences between treatments. Although in Canada results with this mating disruption technique were not always satisfactory either (McBrien et al., 1997), the complete absence of a treatment effect raises a few questions. The timing of the application, one to two weeks before the first second-generation males were captured in the apple orchards, seems to be correct. A problem might have been the experimental lay out, with the control plots adjacent to the treated area. The size of the control plots and the lack of a gradient in nymph densities in spring 1998 make a significant effect of the treatment on the control unlikely.

<table>
<thead>
<tr>
<th>Orchard</th>
<th>Number of traps captured</th>
<th>Trap catch reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linne</td>
<td>6</td>
<td>88</td>
</tr>
<tr>
<td>Kessel</td>
<td>8</td>
<td>99</td>
</tr>
<tr>
<td>Baarlo</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Meterik</td>
<td>6</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 2.** Mean numbers of adult male *C. verbasci* captured in the autumn of 1997 in pheromone-baited traps hung in control plots and in plots treated with 1000 pheromone dispensers per ha

<table>
<thead>
<tr>
<th>Orchard</th>
<th>cv</th>
<th>sample date</th>
<th>control plot 1 nymphs</th>
<th>control plot 2 nymphs</th>
<th>treatment nymphs</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linne</td>
<td>GD</td>
<td>15 May</td>
<td>3.8</td>
<td>2.5</td>
<td>5.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Kessel</td>
<td>GD</td>
<td>15 May</td>
<td>2.6</td>
<td>1.9</td>
<td>2.4</td>
<td>3.2</td>
</tr>
<tr>
<td>Baarlo</td>
<td>GD</td>
<td>20 May</td>
<td>31.0</td>
<td>3.2</td>
<td>31.0</td>
<td>2.8</td>
</tr>
<tr>
<td>Meterik</td>
<td>E</td>
<td>19 May</td>
<td>25.3</td>
<td>9.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Meterik</td>
<td>G</td>
<td>19 May</td>
<td>14.7</td>
<td>5.7</td>
<td>6.3</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Table 3.** Mean numbers of *C. verbasci* nymphs per limb-tap sample of 50 branches (+ standard deviation, sd) in the spring of 1998 in control plots and in plots treated with 1000 pheromone dispensers per hectare in the previous autumn. Samples were taken from cultivars (cv) Golden Delicious (GD) and Elstar (E)
An unknown factor is the behaviour of the females; where and when do the females mate? The main known summer host, common mullein, is rather scarce in the area, and although damage can be serious, the numbers of *C. verbasci* in Dutch apple orchards always seem to be much lower than in some Canadian orchards. It might be that apple is one of several winter hosts here, and that *C. verbasci* is only an accidental guest, with lots of chances for females to get fertilised on their way to the orchard.

REFERENCES


