Evaluation of an active mating disruption concept against codling moth 
(Cydia pomonella) under the aspects of different application systems 
and varieties

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Abstract
Beside standard systems of mating disruption the activity of the product Exosex CM and 
Exosex 2 CM under the aspect of different application systems and several varieties were 
tested at the research station of the Federal College and Institute for Viticulture and 
Pomology Klosterneuburg. Male insects were attracted into the Exosex dispenser by using 
the appropriate pheromone, which acts on the pheromone receptive sensors on the male 
so that they cannot locate calling females. Standard mating disruption techniques usually 
rely on the introduction of amounts of pheromone emitted by natural populations of pest 
species into the atmosphere. Exosex CM significantly reduces deployment time and labour 
costs in the orchards, additionally the flexibility to fit in with IPM programmes was tested. 
The assessments were done visually on windfall fruits, fruits on the tree and on all fruits at 
harvest followed by statistical evaluation. Among the fruits sprayed with the IPM system 
there was an infestation rate of the first (Cydia pomonella) generation at the variety Idared 
of 0,8%, the second generation treated with Exosex showed an infestation of 13%. In the 
biological trial however the infestation by the first generation was about 4% and the 
infestation of the second generation about 31%.

Keywords: codling moth, mating disruption, IPM programmes

Introduction
The aim of this study was to find an alternative method to granulose virus application in 
order to prevent codling moth (Cydia pomonella) damage by population control in a closed 
area using mating disruption. Several alternative control methods of mating disruption 
against codling moth (Cydia pomonella) were demonstrated and evaluated in apple 
orchards in Austria and have become established since 1992. Codling moth (Cydia 
pomonella) is the key pest in the apple orchards of the research station Haschhof in 
Klosterneuburg, Austria (Polesny, 2002). In the last eight years it was primarily controlled 
by routine applications of granulose virus. 2007 a new system, Exosex a confusion 
pheromone dispenser system developed by Exosect Ltd. UK, (Nansen et al. 2007) was 
tested to facilitate the control of codling moth (Cydia pomonella). The system of Exosex 
has shown success in Europe against several Lepidopteran pests at a rate of only 25 
dispensers/ha. This ‘active’ technology approach to mating disruption leads to a reduction 
in mating, egg laying and consequent crop damage with the benefit of very few pheromone 
dispensers. The male codling moth (Cydia pomonella) acts as a mobile pheromone 
dispenser. The aim of this research was to examine the efficacy of this auto–confusion 
technique by assessing the infestation.

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Material and Methods

The research station is situated north of Vienna on the right river bank of the Danube at the foothill of the Wienerwald (the Vienna Woods). The apple orchard is hilly and on a south–east slope. The orchard was split into two sections, each 1 hectare, which were further separated into fields. As can be seen in table 1, field 21, 51 and 52 were treated with methods of integrated production, whereas field 42 only mating disruption agents were applied. Due to the vast population the first variant (V1) included a treatment against the first generation with the spraying agent diflubenzuron, which was applied on 22nd of May to decimate the outgoing population. The second generation being smaller in population was treated with Exosex a mating disruption agent used as an extension to the conventional agent used for the 1st generation. The dispensers were placed on the 11th of July.

In the second variant (V2) mating disruption with a special system, which has not been tested in Austria yet was used for both generations and replaced after six weeks in order to provide constant conditions On the 3rd of May the dispensers were situated on the trees and replaced on the 10th of July. There were several pheromone traps placed to control the activity.

Table 1: trial design

<table>
<thead>
<tr>
<th>variant</th>
<th>PPS</th>
<th>1st generation treatment</th>
<th>2nd generation treatment</th>
<th>fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>IP</td>
<td>diflubenzuron</td>
<td>Exosex</td>
<td>21, 51, 52</td>
</tr>
<tr>
<td>V2</td>
<td>BIO</td>
<td>Exosex</td>
<td>Exosex</td>
<td>42</td>
</tr>
</tbody>
</table>

The two variants were visually assessed on each ten trees (Topaz and Idared) and their windfall fruits on the 23rd of August. The last assessment was done at harvest, where every apple was examined for codling moth (Cydia pomonella) damage.

For the product comparison study, the effects of the treatment on fruit damage were compared for each variant, using ANOVA.

Results

At the beginning of the season the infestation was about 3% higher with variant 2 than with variant 1. With the first generation there were no discernible differences between the varieties. The infestation increased with the second generation. Topaz and Gala showed significantly higher rates of injured fruits than Idared.

Table 2: Assessments of the first and second generation

<table>
<thead>
<tr>
<th>field</th>
<th>variety/PPS</th>
<th>1. generation</th>
<th>2. generation</th>
<th>windfall fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fruit injury %</td>
<td>total number of assessed apples</td>
<td>fruit injury %</td>
<td>total number of assessed apples</td>
</tr>
<tr>
<td>21</td>
<td>Topaz IP</td>
<td>0,5</td>
<td>441</td>
<td>7</td>
</tr>
<tr>
<td>42</td>
<td>Idared BIO</td>
<td>4</td>
<td>568</td>
<td>22</td>
</tr>
<tr>
<td>42</td>
<td>Topaz BIO</td>
<td>5</td>
<td>531</td>
<td>27</td>
</tr>
<tr>
<td>51</td>
<td>Idared IP</td>
<td>0,8</td>
<td>521</td>
<td>13</td>
</tr>
<tr>
<td>51</td>
<td>Topaz IP</td>
<td>0</td>
<td>566</td>
<td>5</td>
</tr>
<tr>
<td>52</td>
<td>Gala IP</td>
<td>5</td>
<td>587</td>
<td>29</td>
</tr>
</tbody>
</table>
During the season (Cydia pomonella) activity was monitored with the help of pheromone traps. Figure 1 shows the activity of the codling moth (Cydia pomonella) in 2006 and 2007. The activity was similar in both years. Despite the use of the mating disruption system codling moths (Cydia pomonella) were captured throughout the whole growing season.

The codling moth (Cydia pomonella) population was increasing at a significant rate in the ecological variant, from 22% fruit injury in the first generation to 38% at harvest with the variety Idared. However, there was a significant difference between the varieties. So, for instance, Topaz showed an infestation of 43% in the ecological variant, whereas the infestation in the integrated variant was 11%.

Figure 1: Codling moths (Cydia pomonella) captured in pheromone traps on the individual patches

![Codling moth (Cydia pomonella) capture in pheromone traps](http://orgprints.org/13718/)

Figure 2: Final assessment at harvest

![Final assessment at harvest](http://orgprints.org/13718/)
Discussion
In trials testing the dependence of mating disruption success on moth density there were obvious effects with the different varieties and also with either the ecological variant or mating disruption in connection with an application on the first generation. The attraction of the codling moth (Cydia pomonella), to apple volatile compounds which are known to elicit an antennal response was often tested and there exist differences between the varieties (Corarini et al. 2004).
It is equally well known that the mating disruption technique does not work well with high population densities (Cardé & Minks 1995, Neumann 1997, Casgrande & Jones1997), which was the case in the trials. The pest pressure was higher than 1% due to the organic cultivation and the adverse conditions on the sloping site.
Moths were always found in the traps, even when mating disruption was used. Also, examinations of the fruit at harvest showed an extremely increased activity as compared to the first assessment.

References
Neumann U. (1997), Successful employment of pheromones in apple: exemplary results from Europe, IOBC wprs Bulletin, 20(1) 73-78