Improving the use of pheromone puffer technique for codling moth control

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Introduction

Codling moth *Cydia pomonella* is an important pest of fruit crops in Europe. Pheromone mating disruption can be an effective tool to control this pest. In recent years, low-density pheromone dispenser systems have been developed, using a few aerosol puffers per hectare. Application of the technique requires less labour than traditional hand-applied mating disruption, but efficacy of puffer systems may be prone to adverse effects of weather and orchard topography. We investigated how to mitigate these effects.

Objectives

- Improve the use of semiochemicals for insect pest management
- Understand the effects of weather and orchard topography on the efficacy of the pheromone puffer technique
- Adapt the technique in order to mitigate control failures

Cage experiments

Semios CM pheromone puffers were distributed symmetrically in a square 5 hectare apple orchard in the Netherlands, following standard installation protocols. Distance between the puffers was 60 m. Transects of large field cages were installed throughout the orchard in three zones: exterior (just outside the outer row of puffers), 1st orbit (between the 1st and 2nd concentric row of puffers) and centre (Fig. 1). Males of *C. pomonella* were released in the field cages, and sticky traps with virgin females as lure inside these cages were used to measure the ability of males to find females. Moths were released in the afternoon and catches in the traps were recorded the next morning.

Results

- In the centre of the pheromone treated field, no male moths were recaptured on three different occasions (Fig. 2).
- In cages near the orchard border, the largest fraction of males was recaptured. On average, 28% of the males were able to find the virgin females during the first night after release.
- Wind direction had a strong and significant effect on the number of males recaptured. The highest numbers of males were always recaptured at the upwind side of the field.

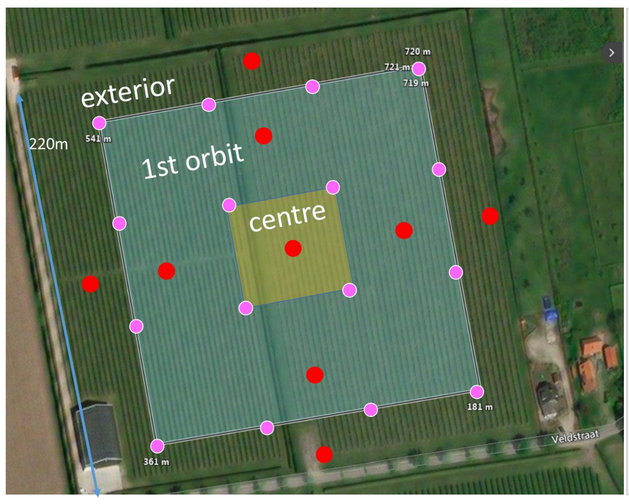

Figure 1. Design of mating disruption cage experiment (pink = dispensers, red = field cages.

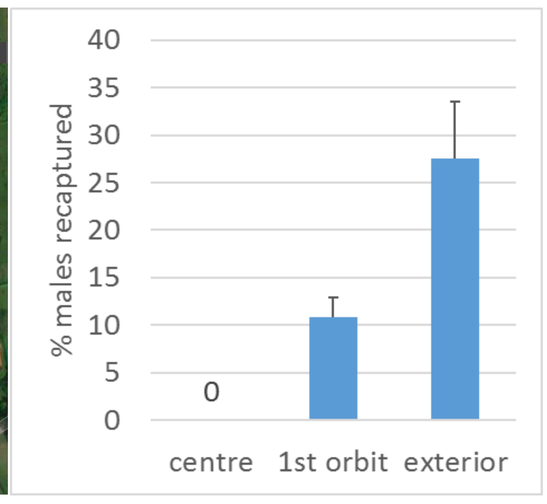

Figure 2. Percentage of males recaptured after one night in cages at different positions in the field at three different dates in 2018.

Large scale field experiments

Semios CM pheromone puffers were installed in two orchards with large codling moth populations. Pheromone traps were placed 1) near the upwind border; 2) in line with the outer row of pheromone puffers; and 3) in the interior part of the field (Fig. 3). In consequence of the results obtained in 2016, the distance from the first puffer lines to the borders was reduced to 20 m in 2017. In addition, puffers were raised about half a meter above the apple trees.

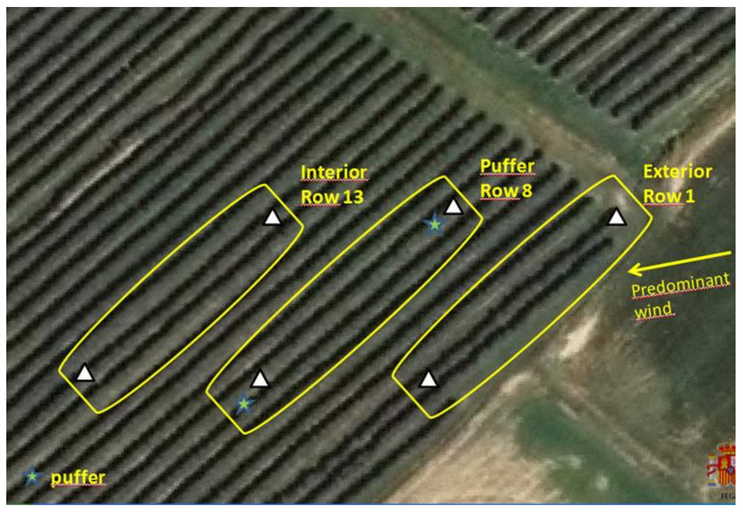

Figure 3. Position of pheromone traps (white triangles) and puffers (green stars) in Tarròs (Spain) in 2016. Arrow indicates the predominant wind direction. Right: pheromone puffer.

Results

In 2016, 70% of the total male catches were in the upwind border area (Exterior, Fig. 4), indicating an insufficient efficacy of the mating disruption in border rows. Decreasing the distance from puffers to border to 20 m in 2017 allowed to better cover the border area. With this alteration, we observed a much more even distribution of catches at the different parts of the orchard.

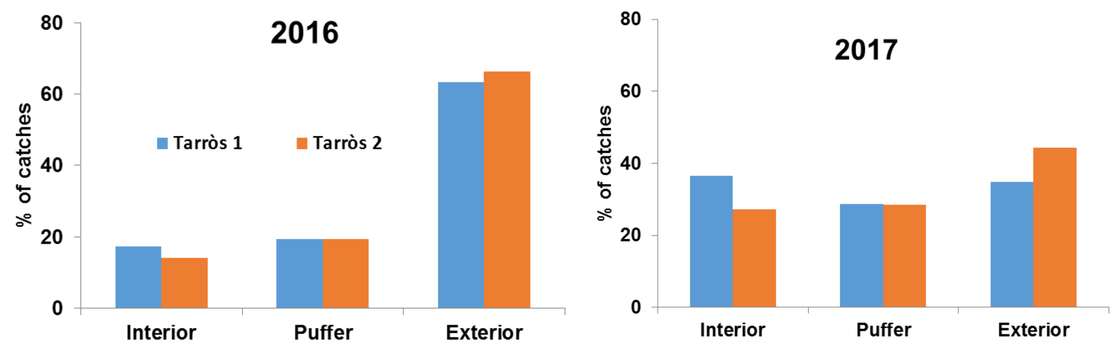

Figure 4. Distribution of catches of male *C. pomonella* in pheromone traps in different parts of 2 pheromone-treated orchards (see Fig. 3) in 2016 and 2017 in Tarròs, Spain.

Conclusions

Failure of mating disruption at orchard margins is often attributed to the immigration of gravid females, and considered as an inevitable property of the technique. Our results sustain a different vision. The presence of "pheromone gaps" at the upwind borders of orchards leads to an increased probability of male-female moth encounters. Redistributing dispensers near the actual orchard border strongly reduces this problem. This was confirmed in field experiments with a high pest pressure in Spain. The insights obtained allow us to increase the total efficacy of the system. This will lead to an improved adoption of this new technique by fruit growers.

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Pheromone dispensers and support were kindly provided by Semios Technologies Inc., Canada

This project has been funded under the European Union's Horizon 2020 research and innovation programme under grant agreement n. 634179.

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