International Journal of Horticultural Science 2007, 13 (3): 51–53
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Results on mating disruption by sex pheromones against moth pests of apple in integrated and organic orchards

Újvári, I.[1] & Holb, I.[2]

[1] *Biocont Magyarország Kft, Budapest*
[2] *University of Debrecen, Centre of Agricultural Sciences, Department of Horticulture and Plant Biotechnology, H-4015 Debrecen, 138 Böszörményi Street, Hungary*

Summary: The study was aimed to study that how mating disruption by hand applied dispensers can reduce the number of damage caused by *Cydia pomonella*, *Adoxophyes orana* and *Pandemis heparana* in four integrated and organic apple orchards. In the first orchard (Gacsály), protection against moth caterpillars ensured by IPM and conventional production systems were equally good, but worse than that of the orchard part where mating disruption was applied by 1000 dispensers/ha. In second orchard (Nyírbogdány), the highest incidence of codling moth damage was measured in the hilly part (17%), while in the plot where 440 dispensers/ha pheromone dosage was applied, the damage incidence was 11%. The smallest damage incidence was at the flat part, where 666 dispensers /ha was applied. In the third and fourth orchards (Eperjeske), codling moth damage on fruits was below 7% in the larger and smaller orchards where 1000 dispensers/ha was applied. At Eperjeske, the codling moth damage increased by 32.3% in the field treated with *Bacillus thuringiensis* product but without using mating disruption. The results verified that the use of 1000 dispensers/ha as suggested by the manufactures is essential, especially in the first year of application. The results also suggested that better results can be achieved in flat areas and the larger plot size also enables a more efficient reduction of the damage.

Key words: mating disruption, hand applied dispenser, sex pheromone, tree banding trap, apple, organic, integrated management

Introduction

Similarly to pheromone traps, mating disruption builds upon communication between males and females within a given species. Directly before swarming, a very high concentration of the pheromone similar to that of the female moth is created in the air of the orchard. This high pheromone level is maintained throughout the whole year, in this way, the chances of moths finding each other is reduced through the whole season (*Jones*, 1998). Meeting of males and females can be disturbed by following a false trail, adaptation, masking the fragrance and by sensory imbalance (*Champion* et al., 1989). Accordingly, reproduction of moths and the resulting number of larvae can be reduced successfully. By using mating disruption against the key pests the use of chemical insecticides and the environmental pollution by chemicals can be reduced, the produced products will contain less pesticide residues (*Jones*, 1998).

There are three main methods for the application of pheromones (*Champion* et al., 1989; *Jones*, 1998; *Molnárné & Holb*, 2005): i) hand-applied dispensers: moderate release rate, several hundreds of dispensers are necessary for a hectare; ii) aerosol emitters: high release rate, a few emitters per hectare are enough, iii) microencapsulated formulations: very low pace of pheromone release, several millions of microcapsules are necessary for one hectare.

Several domestic studies have applied mating disruption in grape, apple, pear and peach orchards (*Neumann* et al., 1993; *Neumann*, 1993; *Ráduly* et al., 1995; *Veisz*, 2001; *Holb* et al., 2005).

In our experiment, we studied how mating disruption by hand applied dispensers can reduce the number of moth pests in integrated and organic apple orchards.

Materials and methods

Pheromones

For mating disruption, the pheromone dispensers of the Japanese Japán Shin-etsu company distributed by Biocont Magyarország Ltd. Were used. Three types were applied int he experiment: i) Isomate C plus, containing pheromone only against codling moth ii) Isomate CTT and iii) Isomate CLR containing a combined pheromone against codling moth (*Cydia pomonella*), *Adoxophyes orana* and *Pandemis heparana*.

Experimental orchards and application methods of pheromones

The experiment was carried out in four different apple orchards (Gacsály, Nyírbogdány, Eperjeske A and Eperjeske G,) in the northeastern part of Hungary. Dispensers were placed before swarming between 16 April and 1 May 2006.

One thousand hand-applied dispensers were placed out per hectare depending upon the between-row and within-row distance. A frame was formed in the outermost rows all treatment areas where a double amount of dispensers were placed. With this method, we aimed to counterbalance the reduction of the pheromone concentration at the edge of the field.

Gacsály: A 5-hectare intensive orchard was used for mating disruption. The field has a support system and drip irrigation system. No grass was grown in the alleys. The spacing of trees was 4×1 m. Around the field, young apple trees have been planted which have not been yielding yet. Integrated pest management is applied in the orchard. For mating disruption, the Isomate CLR combined product was used. 5200 dispensers have been placed into the plot. Three technologies were compared at Gacsály:i) mating disruption combined with IPM technology (11 insecticide treatments, ii) IPM treatments without mating disruption (2 insecticide treatments) and iii) traditional crop protection technology without mating disruption (13 insecticide treatments).

Nyírbogdány: Mating disruption was used on 30 ha at a reduced dosage as compared to the recommended 1000 dispensers per hectare. The orchard was divided into three parts i) hilly part with 666 dispensers/ha ii) 40% dosage (400 dispensers/ha), and iii) flatland part with 666 dispensers/ha. The area was divided into two parts by a fence and a road. The plots started to yield in the previous year and the year of the experiment. The plots were not irrigated, there was no grass grown in the alleys. In the middle of one of the plots, there has been inland water for a long period. The spacing of the trees was 5×3 m. The plot was surrounded by an alley of trees from all sides, but at one side there was an old, treated apple orchard on the other side of the alley. Treatments were carried out using Isomate C plus.

Eperjeske (A): The area treated by pheromone was about 3.5 ha of a yielding orchard surrounded an alley of trees from three sides. At the fourth side, a grass area was located. The nearest apple orchard was at about 100 m from the plot, it has also been treated by pheromone. 3800 dispensers of Isomate C plus were placed in the plot. The spacing of trees was 6×4 m. There was grass in the alleys between the rows. Two treatments were carried out against codling moth by using a *Bacillus thuringiensis* product. The control area was an older orchard at 500 m distance from the pheromone plot. In this orchard, treatments were carried out with *Bacillus thüringiensis.*

Eperjeske (G): A 12-ha field consisting of scab-resistant cultivars was used for mating disruption. Isomate C plus containing a pheromone against codling moth only was applied at a dosage of 1000 dispensers/ha. The field was a grass-covered organic orchard. The spacing of trees was 7×3 m. 13 200 dispenser were placed out in the field. Other treatments were not applied against codling moth.

Assessments

The presence of codling moth was studied by two methods:

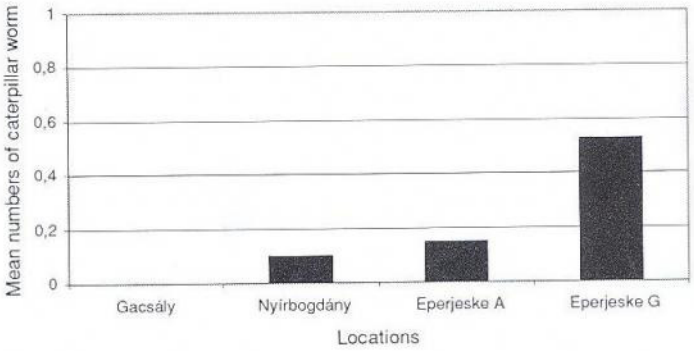
i) *Tree banding traps:* With this method, we aimed to determine the number of worms moving to form a pupa after the first generation. Therefore, tree banding traps were placed around the trunk of the trees in the third decade of June. The banding traps were placed in groups of tens at different parts of the orchard. The banding traps were made out of bulking paper and were fixed to the trunks at their middle part. The banding traps were removed in the third decade of August and the worms and pupae in them were counted.

ii) *The number of damaged fruits:* In this method, the number of damaged fruits was assessed in the second half of July after the swarming of the first generation and then at the end of August after the swarming of the second generation. Samples of 5×30 were taken from several parts of the field.

Results

Results from the tree banding traps

Codling moth larvae and pupae were found in three locations (*Figure 1*). In the field at Nyírbogdány, the average number of larvae per tree was 0.1, while at Eperjeske A and G, the number of larvae per tree was 0.15 and 0.55, respectively. No larvae forming a pupa were found in the orchard at Gacsály.



Band traps (10 pieces)	1.	2.	3.	4.	5.
Nyírbogdány	0	1	1	0	3
Gacsály	0	0	0	0	
Eperjeske (A)	0	0	3	3	
Eperjeske (G)	1	1	13	6	

Figure 1 Mean number of worms counted in ten tree banding traps in four apple orchards (Hungary, 2006)

Damage incidence on fruits

The damage incidence at Gacsály under mating disruption was below 0.35% at both assessments (*Figure 2*). At the assessment after the first generation, protection ensured by IPM and conventional technology were equally good, but worse than that of the orchard part where mating disruption was applied. At the second assessment, however, damage incidence caused by codling moth was more than 9% and 13.5% in the IPM treated and conventionally treated parts, respectively.

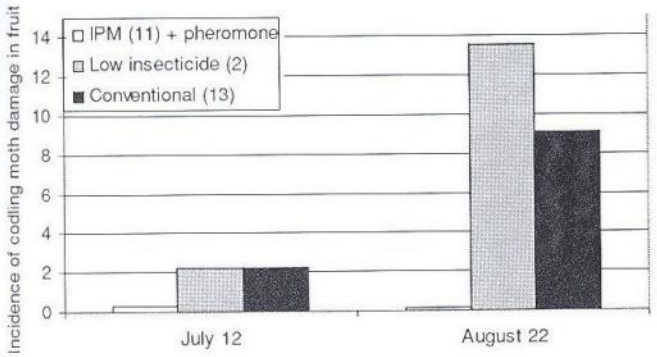


Figure 2 Mean incidence of codling moth damage in fruit in three treatments (IPM and 100% pheromone dose with 11 insecticide sprays, Low insecticide treatment with 2 sprays and Conventional with 13 insecticide sprays) at Gacsály (Hungary, 2006)

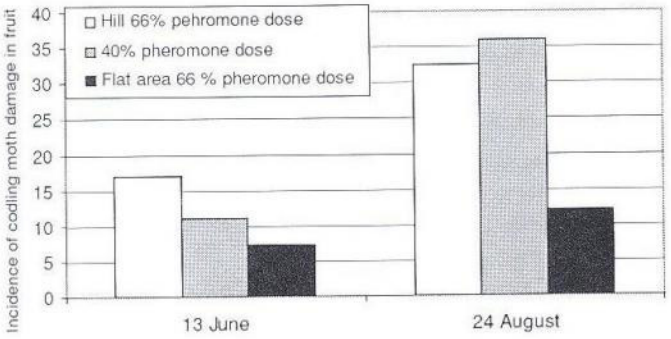


Figure 3 Mean incidence of codling moth damage in fruit in three treatments (Hill with 66% pheromone dose, 40% pheromone dose, Smooth area with 66% pheromone dose) at Nyírbogdány (Hungary, 2006)

At Nyírbogdány, the highest damage incidence was measured in the hilly part after the first assessment (17%) (*Figure 3*). In the plot where 40% pheromone dosage was applied, the damage incidence was 11%. The smallest damage incidence was measured at the flat part, where 666 dispensers were used per hectare. After the second assessment, the damage incidence was the lowest again for the flat area. Damage incidence in the hilly part and in the plot treated with 40% dosage increased to 32.44% and 36%, respectively.

Damage incidence after the first assessment at Eperjeske was 2% and 4.33% in the larger and smaller orchard, respectively (*Figure 4*). At the second assessment, damage incidence was 6.33% and 6.83%, respectively. In the field treated only with *Bacillus thüringiensis,* incidence of damaged fruits was 9.67% after the first generation, while by the asssessment in August, damage incidence has tripled (32.33%).

Conclusions

In 2006, fruit damage incidence could be kept under 7% by applying mating disruption. By applying supplementary

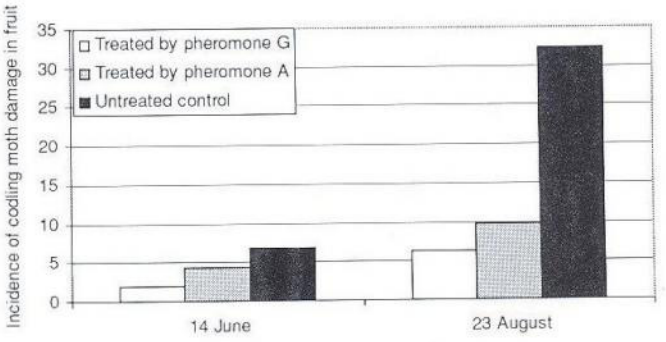


Figure 4 Mean incidence of codling moth damage in fruit in two treatments (treated with pheromone 100% and control) at Eperjeske G and A orchards (Hungary, 2006)

sprayings in addition to mating disruption, fruit damage incidence could even be kept under 1%. The results verified, that the use of 1000 dispensers per hectare as suggested by the manufactures is essential, especially in the first year of application. The results also suggested that better results can be achieved in flat areas and the larger plot size also enables a more efficient reduction of the damage.

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