ECOLOGICAL APPROACH FOR CONTROL OF CODLING MOTH IN THE MOUNTAIN REGION OF BULGARIA

Hristina Kutinkova, Vasiliy Dzhuvinov
Fruit Growing Institute, Ostromila 12, 4004 Plovdiv, Bulgaria

Abstract

The experiment was carried out in an apple orchard in the Central Balkan Mountains of Bulgaria, in 2006 and 2007. Mating disruption (MD) was tested as an alternative method for controlling codling moth (CM), *Cydia pomonella* L., from post-bloom till harvest. Ecodian CP (Isagro) pheromone dispensers were installed twice during the season. In the reference, conventionally treated orchard, 12-15 insecticide treatments were applied to control codling moth, leaf miners, leaf rollers, aphids and mites: 10-12 of them were aimed at control of CM. In spite of that, the fruit damage reached there 2.3 and 2.6% in successive years. Percentage of damage in plots treated with Ecodian was 0.5 and 0.7%, i.e. below the economical threshold; no outbreak of the pest appearance was noted. So, the MD method, with use of the Ecodian CP dispensers, proved to be an effective means of control. The results obtained may open the possibilities of practical use of the method of mating disruption in Bulgaria. This method should favour preservation of the natural environment and enable production of healthy fruits, not polluted by chemicals.

Keywords: **leaf miners, leafrollers, aphids and mites**

1.Introduction

During the last few decades, the ecological approach in pest control in the agricultural production has become a worldwide tendency. It implies a wider spread of the methods for pest control that can reduce or completely exclude chemicals polluting the environment. The most frequently applied methods are those related to sex pheromones. Their use in monitoring of apple pests is helpful for reducing frequency of chemical treatments. This allows to produce fruits with low residues of pesticides. A more perspective trend consists, however, in application of pheromones for pest control on apple by the method of mating disruption.

The codling moth (CM), *Cydia pomonella* L., is the most important pest of apple worldwide, Dorn et al. (1999). Most of recently applied insecticides have a large spectrum of action, so they eliminate the beneficial entomo- and acarofauna, thus provoking invasion of other pests. Moreover, control of CM by conventional methods, in spite of numerous treatments applied, is often ineffective. Strains of codling moth, resistant to standard insecticides, appeared in many countries. This has been apparently due to the development of resistant CM strains. Charmillot et al. (2007) detected resistance to organophosphates and pyrethroids by testing diapausing CM larvae collected in some Bulgarian orchards in autumn 2005 and 2006. The presence of resistance requires an urgent implementation of non-chemical methods of control of the codling moth.

De Vleger & Klijstra (1993) tested the method of mating disruption (MD) against codling moth in apple orchards of Spain and against the codling moth and three species of leaf rollers in some Dutch orchards. In the areas of low population density, fruit damage was less than 1% in the MD treated plots. With higher densities, the damage at the end of the season could reach 3.4%, versus 3.1% in the chemically treated plot.

Trematerra et al. (1993) presented the evidence that in three Italian fruit growing regions chosen for the test, the results of the two-year experimentation with MD were variable, albeit rather positive in general. According to Quarles (2000), mating disruption may be a major method for control of *Cydia pomonella*. Calkins et al. (2001) applied the method of mating disruption, using Isomate C plus dispensers in combination with the limited insecticide treatments against codling moth. Albert & Witzgall (2001) established that mating disruption was a method, which could be successfully applied in commercial apple orchards. Many other successful trials on mating disruption, were reported by Charmillot et al. (1997).

The objective of this study was to test mating disruption of codling moth, with use of Ecodian CP dispensers of the Isagro company, under the conditions of the Central Balkan Mountains of Bulgaria, as an alternative method for control of this pest.

2.Material and methods

In the years 2006-2007, the experiment was carried out in a commercial apple orchard near Sevlievo, Central Balkan Mountains, on a 1-ha orchard plot. 'Idared', 'Melrose' and 'Granny Smith' apple trees were 5-year-old. In 2005 the CM pressure was expressed by the 2-3% fruit damage at harvest.

In both years of study, the mating disruption method was employed using the Ecodian CP dispensers (ISAGRO, Italy), installed twice per season. The Ecodian CP dispensers are small blue hooks, impregnated and contain 10 mg of codlemone. The dispensers were installed for the first time during the season on May 3, 2006 and on April 26, 2007. A second set of dispensers was installed in the second half of July – on July 26 in 2006 and on July 18 in 2007. Each time 2,000 dispensers were hung in the upper 1/3 of the trees over the entire1-ha plot.

Each application required 3 man-hours per ha. Complementary, aphicide treatments were applied in the trial plot in 2006 and 2007, with thiametoxam, because the green apple aphid, *Aphis pomi* de Geer, appeared in high density in May and June in this region.

Another commercial apple orchard, with an area of 1.5 ha and similar age, located in the same region, served as a reference. The total number of insecticides applied in this conventionally treated orchard to control CM, leafminers, leafrollers, aphids and mites were twelve in 2006 and fifteen in 2007. They included fenitrotion, cipermetrin+clorpyrifos ethyl, triflumuron, deltametrin and thiacloprid. Ten to twelve of them were aimed at control of CM.

In both orchards (trial and reference), dynamics of CM flights was monitored by two triangular traps Pherocon (Trécé, USA) – with sticky changeable bottom baited with a standard pheromone capsule (Trécé, USA), containing 1 mg of codlemone. The traps were installed every year in the middle of April and removed at the end of October, i.e. about 3-4 weeks after the last recorded catches. Traps were checked twice a week and the caught moths were removed after counting. The pheromone baits were renewed every month.

Evaluation of fruit damage was carried out several times during the season on 1000 fruits and before harvest on 2000 fruits. In June, corrugated cardboard band traps were wrapped around randomly selected tree trunks in the experimental plot; 30 bands in the trial orchard and 40 in the reference orchard (6 at the border and 24 inside in the trial and 8 at the border + 32 inside of the reference). They were recovered in autumn in order to count the diapausing larvae and thus the hibernating population of CM was estimated.

3.Results and discussion

In 2006 in the reference commercial orchard near Sevlievo, the first flight of CM began on May 5, whereas at the same time no moths were recorded in the pheromone trap installed in the trial plot. The flight of the overwintering generation of codling moth reached its maximum by the third decade of May (Fig. 1). The flight of the second generation, which overlapped the first one, started in the first decade of July, reached its maximum during the third decade of this month, then decreased in mid-August and finished by middle of September.

In 2007 the first flight of CM in the reference orchard was noted on April 30, whereas again no moths were found in the trial (Ecodian CM treated) plot. The flight of the overwintering generation of codling moth reached its maximum by the second decade of May (Fig. 2). The flight of the second generation, which did not overlap the first one, started in the first decade of July, reached its maximum during the second decade of this month, then decreased until the end of August and finished by the third decade of September. In the Ecodian treated orchard near Sevlievo, the standard sex trap of 1 mg codlemone during both seasons, 2006 and 2007, has not caught any moth, whereas in the reference orchard 98 and 123 moths were caught in total during the whole 2006 and 2007 season, respectively.

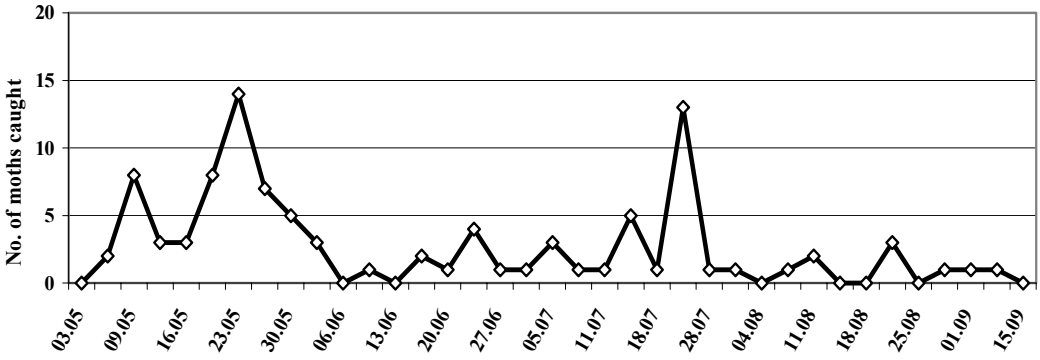

Figure 1. Flight dynamics of CM in the reference orchard in 2006

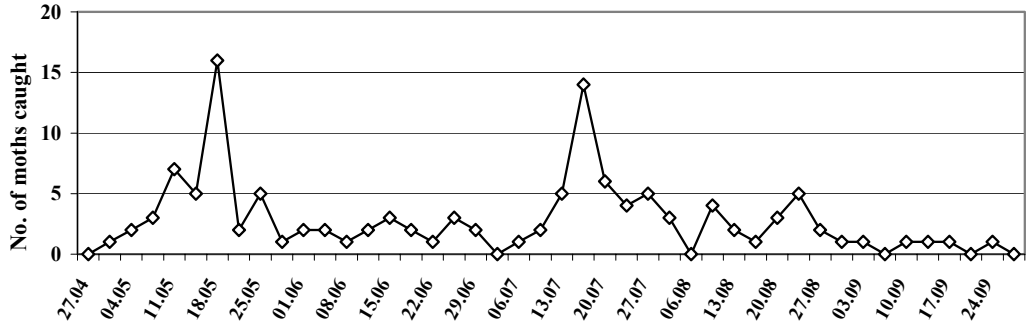

Figure 2. Flight dynamics of CM in the reference orchard in 2007

In 2006 in the experimental plot, the damage rate was 0.3% on June 16, and increased before the second application of Ecodian dispensers (at the second decade of July) to 0.6% (Table 1). Then it decreased to 0.5% in the third decade of August and stabilised at the same level at harvest. In the reference orchard the fruit damage progressed from 1.3% on June 16 up to 2.3% at harvest. In the Ecodian trial plot, the overwintering population in autumn 2006 amounted to only 0.275 larvae per tree in the experimental plot, whereas in the reference orchard it reached 1.3 larvae per tree.

In 2007 the damage rate in the trial plot was nil on June 3, then reached 0.5% in the third decade of July (Table 2). Then it increased to 0.6% in the third decade of August and stabilised at the same level before harvest. At harvest, the damage was only 0.7%. In the reference, the orchard damage progressed from 1.40% on June 25th up to 2.6% at harvest. The overwintering population in autumn 2007 was only 0.375 larvae per tree in the trial plot, whereas in the reference orchard it reached 1.7 larvae per tree.

Table 1. Evolution of fruit damage (%) and the overwintering larval population of CM in the Ecodian trial plot and in the reference orchard in 2006

Index	Date	Sevlievo Ecodian trial plot	Near Sevlievo reference orchard
Fruit damage [%]	June 2	0.0	0.0
	June 16	0.3	1.3
	July 5	0.0	0.0
	July 19	0.6	1.4
	August 15	0.5	1.6
	August 27	0.5	2.0
	September 20	0.5	2.3
	preharvest	0.5	2.0
	at harvest	0.5	2.3
Larvae per tree in bands	autumn 2006	0.275	1.3

Table 2. Evolution of fruit damage (%) and the overwintering larval population of CM in the Ecodian trial plot and in the reference orchard in 2007

Index	Date	Sevlievo Ecodian trial plot	Near Sevlievo reference orchard
Fruit damage [%]	June 3	0.0	0
	June 25	0.0	1.4
	July 5	0.0	0
	July 23	0.5	1.5
	August 26	0.6	1.3
	September 5	0.6	2.0
	September 22	0.7	2.6
	preharvest	0.6	2.0
	at harvest	0.7	2.6
Larvae per tree in bands	autumn 2007	0.375	1.7

4.Conclusions

Positive results obtained in our trials have shown that the mating disruption may be effective in controlling codling moth under the conditions of Central Balkan Mountains of Bulgaria and that Ecodian dispensers may be useful in employment of this method.
The results obtained may open a path for practical use of mating disruption for control of fruit plant pests in Bulgaria. This method should favour preservation of natural environment and enable producing healthy fruits, not polluted by chemicals.

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