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Sustainable Control of Oriental Fruit Moth, *Cydia molesta* Busck, Using Isomate OFM Rosso Dispensers in Peach Orchards in Bulgaria

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The trials were carried out in the years 2011-2013 in an isolated peach experimental orchard of one ha in the Fruit Growing Institute, Plovdiv – Central South Bulgaria. Mating disruption (MD) was tested as an alternative method controlling oriental fruit moth (OFM), *Cydia molesta* Busck from post-bloom till harvest. Isomate® OFM rosso (Shin Etsu - Japan) pheromone dispensers were installed once during the season, before the start of OFM flights. In 2013 Cidetrak® PTB dispensers were used against *Anarsia lineatella* Zell. For monitoring of the pests one type of pheromone traps was used in this experiment - PHEROCON® VI Delta traps (Trécé, USA) with a sticky changeable bottoms. The pheromone baits are a products of Trécé, Inc. USA. In the reference, conventionally treated orchard, 5-9 insecticide treatments were applied to control oriental fruit moth, peach twig borer (PTB), aphids and other pests. In spite of that, the fruit damage ranges from 3.6 to 5.2 % in the successive years. Percentage of damage in the experimental orchard treated with Isomate® OFM rosso was 0.1 and 0.3 %, i.e. rather below the economical threshold; no outbreak of the OFM appearance was noted. So, the MD method, with use of the Isomate® OFM rosso dispensers, proved to be an effective means of control even in a small size orchard lots. 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.

1. Introduction

Oriental fruit moth (OFM) *Cydia molesta* Busck (Lepidoptera: Tortricidae) is a major worldwide pest of peach and nectarine *Prunus persica* (L.) (Rothschild and Vickers, 1991). Originally from north-western China, oriental fruit moth is now a widely distributed pest throughout the world among the major stone-fruit growing regions of Europe, Asia, America, Africa, Australia and New Zealand (Chapman and Lienk, 1971). In Australia, this insect is a key pest damaging commercial stone and pome fruit, including peaches, nectarines, apricots, plums, pears and apples (Il'ichev A. et al., 2006). In Bulgaria OFM is the most important pest of peach, nectarine in the commercial orchards. Its larvae cause damage, infesting shoots and fruits**.** The larvae of early OFM generations damage current season shoot tips, then they feed in the developing fruitlets and fruits. The larvae of summer generations damage mainly fruits. The chemical pest control in peach and nectarine fruit orchards of Bulgaria has relied on a broad spectrum of organophosphate and pyrethroid insecticides. Recently their effectiveness is decreased, apparently due to the development of resistance in the pest. However it is not well documented so far. Although quite effective, environmental problems and consumer concerns have arisen. Deregulation of many of the insecticides used in the control of this pest along with public demand for residue free products, has increased the interest for innovative tools in pest management. Behaviour modifying pheromones can be used for environmentally safe insect management and the technique has become one of the most important instruments for controlling the main pest in the orchards. Mating disruption technology has been successfully used for control of oriental fruit moth, *Cydia molesta* Busck - as reported by

(Barnes and Blomefield, 1997), (Trematerra et al., 2000), (Sexton and Il'ichev, 2000), Kovanci (2003), (Rot and Blazič, 2005), Molinari (2007), (Lo and Cole, 2007), (Kutinkova et al., 2010, 2011, 2012)
The objective of our research, carried out in the years 2011-2013, was to evaluate the efficacy of Isomate® OFM rosso dispensers of oriental fruit moth, as an alternative method for control of this pest under Bulgarian conditions.

2. Material and methods

The trials were carried out in the years 2011-2013 in an isolated peach experimental orchard of one ha in the Fruit Growing Institute, Plovdiv – Central South Bulgaria. Mating disruption (MD) was tested as an alternative method controlling oriental fruit moth (OFM), *Cydia molesta* Busck from post-bloom till harvest. Isomate® OFM rosso (Shin Etsu - Japan) pheromone dispensers were installed once during the season and were hung in the upper third of tree canopy with a density of 500 pieces per ha, before the start of OFM flights. According to the manufacturer, each dispenser is loaded with a minimum 240 mg pheromone mixture.
These dispensers are designed to deliver a long-lasting performance for the whole season, with remarkably fast application. Against other pests occurring in the trial plots, aphicide treatments (one or two per season) were applied during the years of study. In 2011 and 2012 *Anarsia lineatella* was controlled by insecticide treatments, whereas in 2013 Cidetrak® PTB dispensers were used. They are small black hooks, impregnated with pheromone mixture, 240 mg a.i. per dispenser. These dispensers were installed with a density of 400 pieces per ha, before start of PTB (peach twig borer) flights.
Another 1 ha site served as a reference orchard and was treated in a conventional way. It was located in the same region 150 m far from the experimental orchard. From five to nine chemical treatments were applied there during each season, to control OFM and other pests. Five to eight of them were employed against OFM and PTB.
Monitoring of OFM and PTB flight was carried out by sex pheromone trapping in the years of study. Four sticky Delta traps Pherocon® VI were installed in the trial orchard. Two of them were baited with a standard capsule OFM L2 orfamone and other two with PTB L2 anemone. The traps and lures used were products of Trécé Inc., USA. The traps were installed in the centre of the trial orchard before OFM and PTB flight started. For comparison, 4 sticky Delta traps Pherocon® VI, were installed in the reference, conventionally treated orchard. All pheromone traps were checked twice a week.
Early in the season sampling of damaged shoots were carried out on 20 trees, randomly chosen in the trial plot and in the reference orchard. During the season, fruit damages were assessed in the trial and reference plots on 1000 fruits each time. At harvest, 1000 fruits were sampled in both orchards, to evaluate the final damage rate. Significance of differences in damage rate between the trial and reference orchards was estimated by use of Chi-square tests.

3. Results and discussion

In the reference orchard the first flight of oriental fruit moth in 2011-2013 began in the forth week of March or the first and second week of April and finished from the fourth week of September till the second week of October (Figure 1). The pests developed 3 generation during the years of study. The traps installed in the reference orchard caught in total 2117 moths in 2011, 503 in 2012 and 208 in 2013. The population density of OFM decreased season to season. We suppose that dispensers have some action on OFM even in the conventionally treated orchard, because this orchard was 150 m close to the experimental one. In the trial plot, after installation of Isomate® OFM rosso dispensers, no moths were caught in the pheromone traps.
In the reference and trial orchards the first flight of peach twig borer in 2011-2013 began in the first week of May and finished in October. (Figures 2 and 3). In both years 2011 and 2012 the PTB developed 2 generations, which is not typical, it is due to the using of dispensers against OFM in the trial orchard (Figure 3). Probably pheromone mixture of the dispensers used contains components, which suppresses the population density of *Anarsia lineatella Zell.*
So, Isomate® OFM rosso dispensers completely inhibited OFM captures in the pheromone traps, installed in the trial plot, indicating at a high level of disruption. In the 2013 Cidetrak® – PTB dispensers installed in the experimental orchard completely inhibited PTB captures.
In 2011 in the trial plot, where the Isomate® OFM rosso was applied, the damage of shoots was nil on May 10, 24 and 31 and stayed at the same level till the second week of June (Table 1). The economical threshold for bearing orchards is 20%. Damage rates of shoots were significantly different between the treated plot and the reference (Chi-square test, $p < 0.01$). Only one damaged fruit was found in the trial plot at the end of the season; at harvest the fruit damage rate amounted to 0.1%. Fruit damage in the reference orchard progressed

from 2.3% on August 4 up to 3.6% at harvest of the later ripening cultivars. The economical threshold in Bulgaria is 4-6% damaged fruits at harvest time. Damage rates were significantly different between the treated plot and the reference orchard already on August 4 (Chi-square test, $p < 0.01$), and thereafter until harvest (Chi-square tests, $p < 0.001$).

In 2012 in the trial plot, the damage of shoots was nil on May 18 and 21 and stayed at the same level till the 18th of June (Table 2). Damage rates of shoots were significantly different between the treated plot and the reference orchard on May 21 and June (Chi-square test, $p < 0.01$).

Only two damaged fruit was found in the trial plot at the end of the season; at harvest the fruit damage rate amounted from 0.1 to 0.2%.

Fruit damage in the reference orchard progressed from 2.7% on July 25 up to 4.9% at harvest. Damage rates were significantly different between the treated plots and the reference orchard already on July 25 (Chi-square test, $p< 0.01$), and thereafter until harvest (Chi-square tests, $p< 0.001$).

In 2013 in the trial plot, the damage of shoots was nil on May 8 and 17 and stayed at the same level till the end of the second week of June (Table 3). Damage rates of shoots were significantly different between the treated plot and the reference orchard on May 17 (Chi-square test, $p < 0.01$).

Only 2-3 damaged fruit were found in the trial plot at the end of the season; at harvest the fruit damage rate amounted from 0.2 to 0.3%.

Fruit damage in the reference orchard progressed from 2.8% on July 22 up to 5.2% at harvest. Damage rates were significantly different between the treated plot and the reference orchard already on July 22 (Chi-square test, $p< 0.01$), and thereafter until harvest (Chi-square tests, $p< 0.001$).

Table 1: Evaluation of shoot and fruit damage (%) by Cydia molesta in the trial plot and in the conventionally treated orchard in 2011

Index	Date	Damage (%)	
		trial	reference
	May 10	0.0	6.7
shoot (%)	May 20	0.0	18.6
	May 31	0.0	21.4
	June 13	0.0	21.6
fruit	July 8	0.0	0.0
damage (%)	July 22	0.0	0.0
	August 4	0.0	2.3
	August 15	0.0	2.9
	August 26	0.1	3.6
	at harvest	0.0-0.1	0.0-3.6

Table 2: Evaluation of shoot and fruit damage (%) by Cydia molesta in the trial plot and in the conventionally treated orchard in 2012

Index	Date	Damage (%)	
		trial	reference
	May 18	0.0	0.7
shoot (%)	May 21	0.0	21.3
	June 4	0.0	23.5
	June 18	0.0	25.4
fruit	July 6	0.0	0.0
damage (%)	July 25	0.0	2.7
	August 6	0.0	2.5
	August 20	0.1	3.6
	August 27	0.2	4.9
	at harvest	0.0-0.2	2.7-4.9

Table 3: Evaluation of shoot and fruit damage (%) by Cydia molesta in the trial plot and in the conventionally treated orchard in 2013

Index	Date	Damage (%)	
		trial	reference
	May 8	0.0	0.4
shoot (%)	May 17	0.0	18.5
	June 6	0.0	20.5
	June 14	0.0	21.2
fruit	July 5	0.0	1.2
damage (%)	July 22	0.0	2.8
	August 5	0.0	3.0
	August 14	0.2	3.8
	August 21	0.3	5.2
	at harvest	0.0-0.3	2.8-5.2

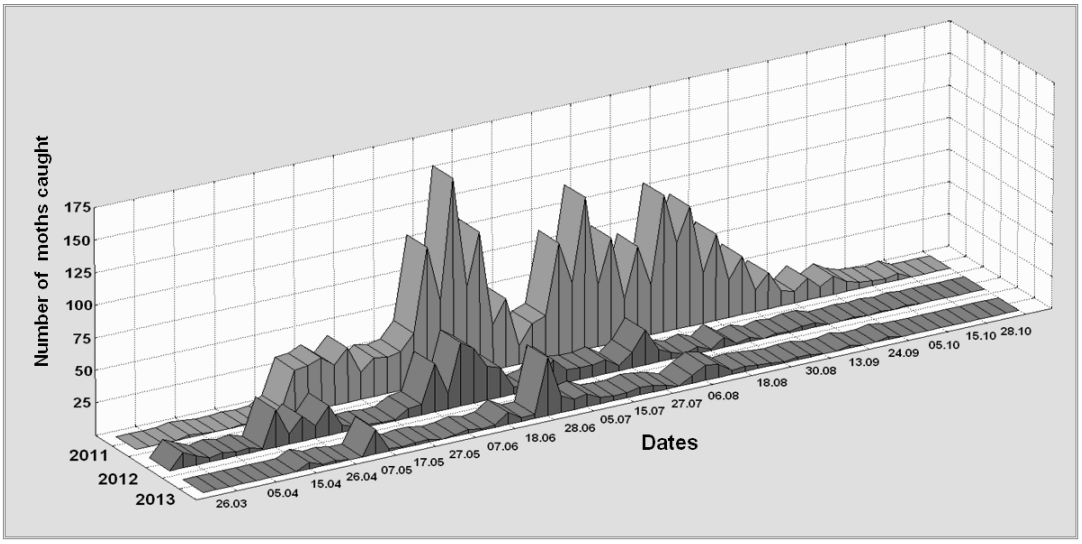

Figure 1. Flight dynamics of oriental fruit moth (Cydia molesta Busck*) in the reference peach orchard in Plovdiv region in 2011- 2013*

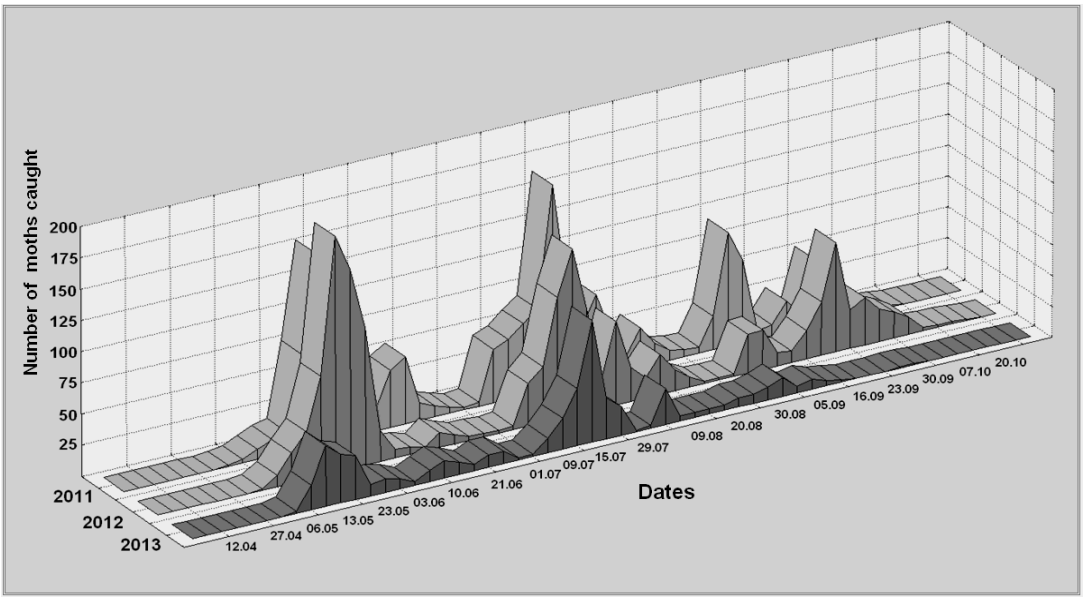

Figure 2. Flight dynamics of peach twig borer (Anarsia lineatella Zell.*) in the reference peach orchard in Plovdiv region in 2011-2013*

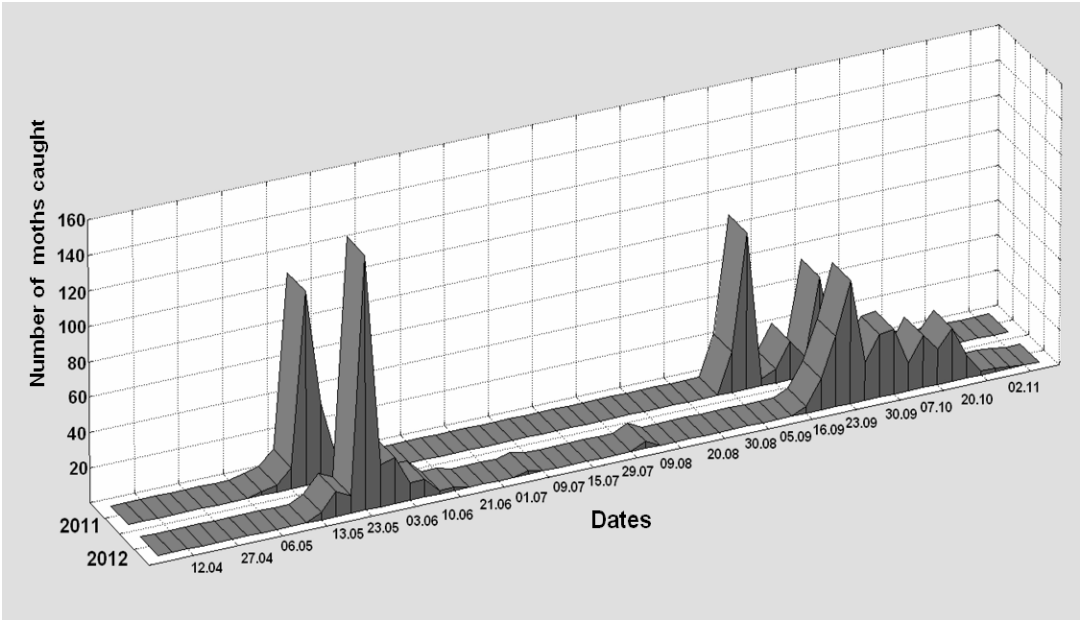

Figure 3. Flight dynamics of peach twig borer (Anarsia lineatella Zell.*) in the trial orchard in Plovdiv region in 2011-2012*

4. Conclusions

Isomate® OFM rosso is effective, when used at dosage 500 dispensers per ha, applied once during the season, before the first onset of OFM, demonstrating that it has an incisive effect even in a small size orchard lots.

For controlling the both important pests in peach orchards, *Cydia molesta* Busck and *Anarsia lineatella* Zell. combined dispensers should be used.

Mating disruption is a perspective alternative to chemical treatments in the peach orchards of Bulgaria.

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