PERTURBAREA ÎMPERECHERII MOLIEI *GRAPHOLITA MOLESTA* BUSCK. PENTRU OBTINEREA UNOR FRUCTE SĂNĂTOASE ȘI DE CALITATE LA PIERȘIC **MATING DISRUPTION OF *GRAPHOLITA MOLESTA* BUSCK. TO IMPROVE QUALITY AND HEALTHY OF PEACH FRUITS**

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Abstract

In Bulgarian fruit growing agriculture mainly chemical plant protection is applied. Applications with organophosphates and pyrethroids are carried out to control the economically most important peach pest - the oriental fruit moth (*Grapholita molesta* Busck.). Annually during the vegetation season 7-8 insecticide treatments are applied. This leads to contamination of fruit products and the environment, which is a prerequisite for seeking other approaches. Regarding to fruit moth, sex pheromones are one of the most widely used environmental control methods, but they are most commonly used in apples. Their introduction in the monitoring of the main peach pest can lead to a reduction of chemical treatments and production with less pesticide residues. A promising direction is the use of pheromones to control the pests through sexual disorientation of males. The trial of mating disruption in the present study were carried out with ISOMATE® OFM TT dispensers in 0.9 ha peach orchard in 2020 and 2021. Pheromone traps type "Delta" of the Hungarian company CSALOMON® were used. The ISOMATE OFM TT dispensers, installed before the first flight of OFM at the rate of 250 units per ha, efficiently reduced fruit damages - down to 0.1-0.2% at harvest. In the reference orchard with 6 insecticide treatment against OFM, the damages reached 3.0-3.6%. The results indicate that mating disruption for control of *Grapholita molesta* Busck. can be used in production of quality and healthy peach fruits.

Cuvinte cheie: perturbarea împerecherii, molia orientală a fructelor, dozatoare Isomate OFM, calitatea fructelor

Key words: mating disruption, oriental fruit moth, Isomate OFM dispensers, fruit quality

1. Introduction

The use of synthetic insecticides since the end of the Second World War has served to increase considerably the world's food production, but these pesticides also compromise the environment and human health (Devine, 2007). Social awareness of the drawbacks of these classical insecticides in the early sixties urged the biotechnological industry to develop safer and more ecologically friendly alternatives (Wright, 1964). One of these alternatives was the interfering with pheromone-mediated mate-finding systems (Witzgall, 2010; Ioriatti, 2011).

Worldwide, agricultural pests affecting more than 800,000 hectares of crops are managed by mating disruption (Benelli, 2019)

Grapholita molesta (Busck) (Tortricidae) is a troublesome pest on peaches, pears, nectarines, plums and apples; its first generation also can inflict significant damage to shoot tips. Its pheromone is a 3-component blend: (Z)-8- and (E)-8-dodecenyl acetates (95:5) with 3-10% of (Z)-8-dodecenol added. This moth seems especially susceptible to mating disruption, with a wide variety of formulation types (micro-dispensers to aerosol puffers) of the pheromone providing excellent fruit protection (Cardé, 2007; Evenden, 2016). As active measures, in 2010, about 50 000 ha were treated yearly with mating disrupting for this moth (Witzgall et al. 2010).

The aim of this study was to test the effectiveness of mating disruption (MD) in control of oriental fruit moth (*Grapholita molesta* Busck.) in peach orchards, using ISOMATE® OFM - TT dispensers.

2. Material and methods

The trials were carried out in Fruit Growing Institute, Bulgaria in 2020-2021.

2.1. Placement and reporting of pheromone traps

Monitoring of oriental fruit moth (*Grapholita molesta* Busck.) flight was observed by sex trapping in both seasons. Two delta traps of the Hungarian company CSALOMON® were installed in 1 ha peach orchard - they were baited with a standard capsule (Csalomon) containing orfomone. The capsules were changed, depending on the warmth of the weather at least 4-6 weeks. The traps were installed in the

center and at the edge of the orchard before oriental fruit moth flight started. The traps were set during the last ten days of March in both seasons; the reports were made - weekly. The sticky boards (bottoms) have been replaced according to a given scheme by the manufacturer (Fig. 1).

Ten treatments were applied there during each season to control oriental fruit moth and other pests. Five of the treatment applications were applied against fruit moth.

2.2. Application of alternative biological means of control (mating disruption)

The Dispensers used are from Sumit Agro - ISOMATE® OFM - TT and are placed in a dose of 250 dispensers per hectare. According to the manufacturer's descriptions, each pheromone dispenser contains: Z-8-dodecenyl acetate - 0.4464 g / dispenser, E-8-dodecenyl acetate - 0.0288 g / dispenser, Z-8-dodecenol - 0.0048 g / dispenser (479.52 mg active ingredients per dispenser). According to the list of permitted plant protection products for Bulgaria, ISOMATE® OFM - TT have a category of use - non-professional. Moment of application before the beginning of the flight of butterflies.

Dispensers (Fig. 2) for sexual disorientation of the oriental fruit moth *Grapholita molesta* (Busck.) were placed during the first ten days of April in 1 ha peach experimental orchard. According to the manufacturer's recommendation, the placement height is 2/3 of the total height of the trees, once during the growing season.

Data on catches moths in the pheromone traps were considered as totals for each date of observation and presented in a graphical form.

Against other pest occurring in the trial plot, only two aphicide treatment was applied each in 2020 and 2021.

2.3. Indices studied

Early in the season sampling of damaged shoots was carried out on 10 trees (10 shoots per tree), randomly chosen in the trial plot with dispensers and in the reference orchard. The 1st shoot assessment was 10-14 days after the first OFM generation and the 2nd shoot assessment: 10-14 days after the 2nd OFM generation. An economic damage threshold for the first assessment should be well below 1% and threshold for concern for the 2nd shoot assessment is 1-2%.

During the season, sampling for fruit damage was carried out in the trial and reference plot on 100 fruits at each sampling. At harvest, 1000 fruits were sampled in both orchards, to evaluate the final damage rate. The economic threshold in Bulgaria is 4-6% damaged fruits at harvest time.

The rate of fruit damage by oriental fruit moth *Grapholita molesta* (Busck.) was expressed as percentage of damages fruit. Significance of differences in damages between orchards was estimated by use of the Chi-square test.

3. Results and discussions

3.1. Oriental fruit moth *Grapholita molesta* (Busck.) flight dynamics

In the main host of the species - peach, the dynamics of flight during the two observed periods has 5 flight peaks. It is most pronounced in the first generation, as butterflies fly from it in significantly changing weather conditions with frequent cold spells (observed during the reporting period). The population density is the lowest in the first generation; this is due to the relatively small winter stock caused by the early harvest and the few suitable places to hide the diapausing caterpillars. The flying activity of the butterflies of the next generations gradually increases, in parallel with the increase of the population density of the species. Subsequent generations do not have a clear boundary and there is an overlap. In 2020, the largest peak is observed in the second and third generation, and in 2021 - the second generation.

The dynamics of the flight of the oriental fruit moth *Grapholita molesta* (Busck.) observed period 2020-2021 in a peach orchard is presented in Fig. 3.

3.2. Application of alternative biological means of control (mating disruption)

In 2020, the flight of the oriental fruit moth *Grapholita molesta* (Busck.) in peach orchards was reported 10 days earlier than in 2021 (Fig. 4). In both observed years, a low population density of the first generation was reported. The highest values of captured males were observed in the second and third generation. The total number of males caught (average per trap) in the control orchard in 2020 is 184 moths, and in 2021 - 168 moths. In the used dispensers orchard the average number is respectively 4 moths for 2020 and 7.5 moths for 2021.

3.3. Evolution of shoot and fruit damage by oriental fruit moth *Grapholita molesta* (Busck.) during the season

In the treated orchard, severe shoot damage by oriental fruit moth *Grapholita molesta* (Busck.) was noted at the third decade of May in both years of study (Table 1). The percentage of damage to shoots increases from 0.3 to 10% in June for 2020, and from 0.2 to 6% for 2021.

In the peach orchard, where ISOMATE® OFM - TT dispensers were used, damage to shoots were observed a month later. The percentage of damage to shoots in 2020 increased from 0.1 to 0.5%, and in

2021 was observed 0.1% reported at the end of June. In both observed years, shoots damage were observed mainly by the first and second generation of oriental fruit moth. Damage rate of shoots were significantly different between orchards on June in both years (Chi-square test, $P < 0.01$).

The first signs of fruit damage were noted in the treated orchard on June 15 in 2020 (0.1%) and on June 30 in 2021 (0.5%). The percentage of fruit damage increased to 3.6% in 2020 on August 20 and 3.0% in 2021 on August 3.

Damage at harvest in orchard with ISOMATE® OFM - TT dispensers reached only 0.2% in 2020 and 0.1% in 2021.

4. Conclusions

Mating disruption is a perspective alternative to chemical treatment. Use of Isomate OFM TT dispensers significantly reduced oriental fruit moth *Grapholita molesta* (Busck.) incidence and damage caused by this pest. The use of MD method will be helpful in meeting the requirements of EU for residue free fruit production.

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Tables and Figures

Table 1. Evolution of shoot and fruit damage by oriental fruit moth *Grapholita molesta* (Busck.) in the Isomate OFM TT trial plot and in the conventionally treated reference orchard in two successive years of study

Index	2020			2021		
	Date	Isomate OFM TT trial plot	treated orchard	Date	Isomate OFM TT trial plot	treated orchard
Shoot damage [%]	May 1	0.0	0.0	May 5	0.0	0.0
	May 10	0.0	0.0	May 15	0.0	0.0
	May 19	0.0	0.3	May 24	0.0	0.2
	May 24	0.0	0.5	June 5	0.0	5.0
	June 5	0.1	10.0	June 15	0.0	6.0
	June 15	0.5	10.0	June 25	0.1	6.0
Fruit damage [%]	June 15	0.0	0.1	June 18	0.0	0.0
	June 30	0.0	0.6	June 30	0.1	0.5
	July 10	0.0	0.6	July 9	0.0	0.5
	July 25	0.3	2.8	July 23	0.0	2.8
	August 10	0.0	2.0	August 8	0.2	3.0
	August 20	0.1	3.6	August 23	0.0	1.6
	preharvest	0.02	2.6	preharvest	0.01	2.8
	at harvest	0.2	3.6	at harvest	0.1	3.0

Fig. 1. Captured male moths of the oriental fruit moth *Grapholita molesta* (Busck.)

Fig. 2. Dispensers Isomate OFM TT for sexual disorientation of oriental fruit moth *Grapholita molesta* (Busck.)

Fig. 3. Flight dynamics of the oriental fruit moth *Grapholita molesta* (Busck.) in the period 2020-2021 in the peach fruit species

Fig. 4. Flight dynamics of the oriental fruit moth *Grapholita molesta* (Busck.) in the period 2020-2021 in the peach fruit species with Isomate OFM TT dispensers