

**Possibility for control of plum fruit moth *Grapholita funebrana* Tr. by pheromone dispensers**

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**ABSTRACT**

The plum fruit moth, *Grapholita* (syn. *Cydia*) *funebrana* on (Tr.), is an important and the most difficult pest to control in plum orchards. The larvae feed fruits and cause damages from early summer till harvest time. For a long time, pest management in stone fruit orchards in Bulgaria relied on organophosphate and pyrethroid insecticides. Considering environmental concerns the eco-friendly means of control, alternative to chemical insecticides are urgently needed. The ecological approach imposes a wider application of the methods of pest management that decrease or completely eliminate the use of chemicals polluting the environment within the integrated fruit production systems. Mating disruption (MD) is a promising solution for control of different pests, particularly plum fruit moth. The possibilities for reducing the number of treatments with chemical insecticides against pests in plum orchards of Bulgaria using synthetic sex pheromones have been studied. The trials were carried out in an isolated 2.5-ha private plum orchard in three consecutive years 2017 - 2019. Catches of male moths in pheromone traps were almost completely inhibited in the MD block, whereas they were numerous in the reference, conventionally treated orchard during all years of study. Isomate OFM TT dispensers, installed before the first flight of *G. funebrana* males, reduced fruit damage significantly. The percentage of fruits containing plum fruit moth larvae was below the Economic Injury Level (EIL). The positive results obtained in this study indicate that mating disruption for control of plum fruit moth may be an effective alternative to conventional (pesticide) treatments.

**Keywords:** Plum fruit moth, *Grapholita funebrana*, mating disruption, pheromone dispensers, Isomate® - OFM TT

**MS History:** 08.10.2019 (Revised) - 13.12.2019 (Accepted).

**Citation:** Stefanova, D., Vasilev, P., Kutinkova, H., Andreev, R., Palagacheva, N. and Tityanov, M. 2019. Possibility for control of plum fruit moth *Grapholita funebrana* Tr. by pheromone dispensers. *Journal of Biopesticides*, **12**(2):153-156.

**INTRODUCTION**

Plum trees are infested in Bulgaria with a large number of pests. Plum fruit moth *Grapholita* (syn. *Cydia*) *funebrana* (Tr.) is undoubtedly the key pest of plum. The pest has in Bulgaria one spring and two summer generations and is difficult to be controlled (Arnaudov and Andreev, 2002; Lecheva *et al.*, 2003; Andreev and Kutinkova, 2004). The larvae of summer generations feed fruits and cause damage from early summer till the harvest time. For a long time, pest management in stone fruit orchards in Bulgaria has relied on organophosphate and pyrethroid insecticides. Considering environmental concerns the eco-friendly means of control, alternative to chemical insecticides are urgently needed. The ecological approach imposes a wider

application of the methods of pest management that decreases or completely eliminates the use of chemicals polluting the environment within the integrated fruit production systems. Mating disruption is a promising solution for control of different pests, particularly plum fruit moth. Some successful results of trials in Italy on mating disruption of different tortricid pests, including *Grapholita funebrana*, were reported by Veronelli and Iodice (2004). The positive results of the technique mating disruption for control plum fruit moth (Falta *et al.*, 2007; Brouwer *et al.*, 2008; Toffolutti *et al.*, 2008; Riolo *et al.*, 2010; Andreev and Kutinkova, 2010; Kutinkova *et al.*, 2011). According to Charmillot *et al.* (1982), releasing pheromones in all parts of the orchards have been

successful but not in all cases. It seems that some isolation from other orchards is necessary to control *G. funebrana* with pheromones. The aim of this study was to evaluate the effectiveness of mating disruption method for control of plum fruit moth in plum orchards using Isomate® -OFM TT dispensers (Shin-Etsu, Japan).

## MATERIAL AND METHODS

The trial was carried out in a well-isolated, 2.5 ha commercial orchard near the village Graf Ignatievo, Plovdiv region, South Central Bulgaria, that was established in spring 2012. During three successive years, 2017-2019, mating disruption (MD) of *G. funebrana* (GF) was employed using Isomate – OFM TT dispensers, containing (Z) – 8 – dodecyl acetate + (E) – 8 – dodecyl acetate + (Z) – 8 – dodecenol and manufactured by *ShinEtsu Chemical Co Ltd.*, Japan. The dispensers were hung in the upper tree canopy in the first week of April, before the start of GF flights. In 2017 and 2018 dispensers were set at 300 pieces per ha and in 2019 at 200 pieces per ha. Monitoring of GF flight was carried out by sex pheromone trapping in the years of the study. PHEROCON® VI Delta, sticky traps were installed in the trial orchards using a scheme provided by the producer. The traps were baited with standard GF L2 – Funemone lures and changed every 8 weeks. These products - pheromone traps and baits were developed and manufactured by *Trécé Inc.*, USA. All pheromone traps were checked twice a week. Two standard traps were installed in the, conventionally treated reference orchard, located in the same region for comparison. Seven to eight insecticidal treatments were applied during the seasons in 2017 and 2018, to control GF and other pests. During 2019 only two treatments were done due to reference frost damages. During the season, fruit damage was assessed in the trial and reference plot on 1000 fruits twice a month. At harvest, 1000 fruits were sampled in both orchards to evaluate the final damage rate. The rate of fruit damage by GF was expressed as a percentage of damaged fruits. Significance of differences in the damage rate between the

trial and reference orchard was estimated using Chi-square test.

## RESULTS AND DISCUSSION

In the years 2017-2019 the GF developed three generations. The first flight of overwintering generation in the reference orchard in all three years began in the first or second week of April. The light of the last generation finished the second week of September (2017), the first week of October (2018) and the fourth week of August (2019) (Fig. 1). The traps installed in the reference orchard caught in total 1209 moths in 2017, 1865 moths in 2018 and 1068 in 2019. First signs of fruit damage were noted in the reference orchard at the first week of June in all three years. Starting from the middle of June, through August and September, the fruit damage rate increased, reaching finally at harvest 9.2% in 2017, 7.1% in 2018 and 17.1% in 2019. In the trial plot, only a few damaged fruits were found noted at the end of the season; at harvest it was also negligible – 0.5%-0.6% in 2017 and 2018. In 2019, 5% of damaged fruits were found due to the reduced number of dispensers installed. The reduced number was in line with the recommendations of the manufacturer. Damage rates were significantly different between the treated plots and the reference orchard on 10 July and August 10 in 2017; 13 July and August 15 in 2018; 20 July and August 15 in 2019 and thereafter until harvest in all years of the study (Chi-square tests,  $P < 0.001$ ). Catches of male moths in the pheromone traps were completely inhibited in the MD block in 2017 and only (single) individuals were caught in 2018 and 2019 in the experimental orchard, whereas they were numerous in the conventionally treated reference orchard during all years of our study. Isomate® - OFM TT dispensers, installed before the first flight of (GF) males, reduced fruit damage significantly. The percentage of fruits containing plum fruit moth larvae was rather below the Economic Injury Level (EIL) from 0.5% to 0.6% in 2017 and 2018, even in 2019, when 5% damaged fruits was found.

Fig. 1. Flight dynamics of *G. funebrana* in the reference orchard in successive years of study 2017 - 2019

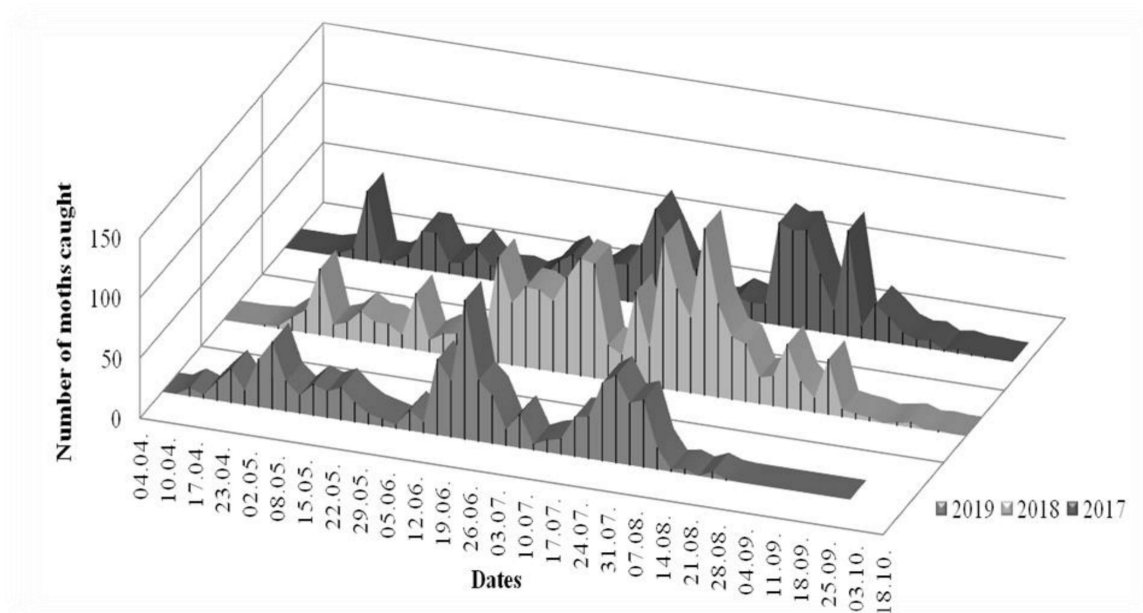


Table 1. Evaluation of fruit damage (%) by *Grapholita funebrana* in the trial plot and in the reference in 2017–2019

2017			2018			2019		
Date	Trial (%)	Reference (%)	Date	Trial (%)	Reference (%)	Date	Trial (%)	Reference (%)
June 7	0.0	0.1	June 5	0.0	0.1	June 7	0.0	0.0
June 15	0.0	1.3	June 18	0.0	1.1	June 15	1.2	3.9
July 10	0.0	1.9	July 13	0.0	2.1	July 5	1.6	5.0
July 31	0.0	3.2	July 29	0.1	4.7	July 20	3.2	15.0
August 10	0.5	7.9	August 15	0.6	6.8	August 15	5.0	17.1
Before harvest	0.5	9.2	Before harvest	0.6	7.1	Before harvest	5.0	17.1
At harvest	0.5	9.2	at harvest	0.6	7.1	At harvest	5.0	17.1

Chi-square tests,  $p < 0.001$

In contrast, in the reference, conventionally treated orchard the damage rate reached between 7.1 and 17.1 %. The present study shows that the damage caused by GF larvae in the reference orchard was considerable, in spite of numerous insecticide treatments

against plum pests. It is suspected that the population of GF in this orchard had become resistant to some of the insecticides used. In contrast, mating disruption by Isomate® - OFM TT dispensers ensures an effective protection from plum fruit moth. In view of increasing concern of consumers in fruit quality and the regulatory restrictions, limiting

the use of many insecticides in the EU, this recent technology may present a promising alternative to conventional protection programmes in plum orchards of Bulgaria. The positive results obtained in this study indicate that mating disruption for control of plum fruit moth may be an effective alternative to conventional (pesticide) treatments. This approach to controlling plum fruit moth is in line with the recent EU recommendations that take care of preservation of the natural environment and production of healthy fruits, with no pesticide residues. Thus it would be helpful in preservation of sound environment and in avoiding any risk of pollution of fruit products with pesticides.

### Acknowledgments

This study is partially supported by the National Scientific Fund of Bulgaria from the Project No. 16/4, 2017 “Competition for financial support for research projects – 2017”.

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