Control of oriental fruit moth *Cydia molesta* and peach twig borer *Anarsia lineatella* by using pheromone dispensers in Bulgaria

Hristina Kutinkova[1], Stefan Gandev[1], Vasiliy Dzhuvinov[1], Bill Lingren[2]

ABSTRACT

Oriental fruit moth (OFM), *Cydia molesta* (Busck) (Lepidoptera: Tortricidae) and peach twig borer (PTB) *Anarsia lineatella* (Zell) (Lepidoptera: Gelechiidae) are economically important pests of peach, nectarine and apricot in Bulgaria. Their larvae cause damage, infesting shoots and fruits. Investigations were carried out in two fruit-bearing commercial peach orchards in South-East Bulgaria in the Sliven district during the period 2014 -2016. The aim of this study was to test the effectiveness of mating disruption (MD) in control of pests in peach orchards, using CIDETRAK® OFM (Oriental Fruit Moth)/ PTB (peach twig borer) and CIDETRAK® OFM/PTB MESO dispensers. The damage to shoots was evaluated during the first generation of OFM and PTB on 20 trees, randomly selected within the central area of each block. Correspondingly, fruit damage was recorded on 100 fruits per each selected tree; so, 2000 fruits were inspected for damage from both pests in each block. The rate of damaged fruits in the trial plots were compared with that in the reference orchard, located in the vicinity, treated with conventional pesticides. CIDETRAK® OFM/PTB (@400 dispensers/ha) and CIDETRAK® OFM/PTB MESO (@80 and 20 dispensers/ha) completely inhibited *C. molesta* in the pheromone traps installed in the trial plots, indicating a high level of disruption. The percentage of shoots infested by OFM and PTB larvae was 0% in the MD plots, and the damage rate to fruits was rather low (>1%). The present results do confirm that mating disruption, using CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers, can provide a more effective control of both important pests on peach - oriental fruit moth and peach twig borer. The use rate of CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers shows that the reduced rate of dispensers does not affect the effectiveness of mating disruption and will help the growers to decrease labour in the field. Applications of these dispensers can provide effective control of oriental fruit moth and peach twig borer, than the conventional protection programmes employed in Bulgaria. This approach to controlling oriental fruit moth and peach twig borer is in line with the recent EU recommendations that emphasize the preservation of the natural environment and production of healthy fruits, with no pesticide residues.

MS History: 22.08.2016 (Received)-16.11.2016 (Revised)- 21.11.2016 (Accepted)

Key words: Peach pests, CIDETRAK® OFM/PTB, CIDETRAK® OFM/PTB MESO dispensers.

Citation: Kutinkova, H., Gandev, S., Dzhuvinov, V. and Lingren, B. 2016. Control of oriental fruit moth *Cydia molesta* and peach twig borer *Anarsia lineatella* by using pheromone dispensers in Bulgaria. *Journal of Biopesticides*, 9 (2): 220-227.

INTRODUCTION

Peach is one of the major fruit species in the south-eastern part of Bulgaria. It provides rapid recovery of investments due to early bearing and relatively small phytosanitary problems. Its main pest is the oriental fruit moth (OFM), *Cydia molesta* Busck (Lepidoptera: Tortricidae). The larvae of early OFM generations damage current season shoot tips; then they feed in the developing fruitlets and fruits. Synthetic female pheromone (Rothschild *et al.,* 1975; Vickers *et al.,* 1985) or pear fruit volatiles (Lu *et al.,* 2012) or plant derived volatiles (Natale *et al.,* 2003) were utilized for *C. Molesta* managements. *Anarsia lineatella* (Zell) (Lepidoptera: Gelechiidae) is a Eurasian species that has spread extensively worldwide; its larvae can develop on many plant species belonging to the genera *Cydonia, Malus, Prunus* and *Pyrus* (Mamay *et al.,*

2014). In Bulgaria the main hosts are *Prunus armeniaca* L. (apricot) and *P. persica* (peach). Semiochemical-based monitoring systems has been a very valuable tool for integrated pest management (IPM) (Jones, 2014) where mating disruption techniques are applied mainly in orchards and vineyards pests control world-wide (Andreadis et al., 2014). For peach pest management, pheromone-based communication disruptor RAK3+4 (dispensers) was used by Navrozidis *et al.* (2005). In 2011-2012, CIDETRAK® OFM/PTB has been utilized for Kutinkova *et al.* (2015) *C. molesta* management in peach orchards at Bulgaria suggested to utilize the same for pest management. In 2007 and 2008, a pheromone dispenser Isonet-A (E-5-decenyl acetate 98-99.5%, E-5-decenol 0.5-2%, 140 mg) was used for the management of *Anarsia lineatella* provide effective control (Öztürk *et al.,* 2010).

The aim of this study was to test the effectiveness of mating disruption (MD) for control of OFM and PTB in peach orchards using CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers developed and manufactured by *Trécé* Inc., USA. The dispensers are designed to deliver long-lasting performance for the whole season, with remarkably fast application

Material and methods

Trial and reference orchards

The investigations were carried out in South-East Bulgaria during the period 2014 -2016. The trial (MD) plots were located in two fruit-bearing orchard blocks (with the size of 2 and 2.5 ha) in the Sliven district. The cultivars grown were Maycrest, Spring Bell, Royal Jam, Big Top, Adriatica, Andros, Babygold 9, O'Henry, Caltesi, Feritime and Morsiani. Mating disruptant products, CIDETRAK® OFM (Oriental Fruit Moth)/ PTB (peach twig borer) was applied at 400 dispensers/ha and CIDETRAK® OFM/PTB MESO (Trece Incorporated, USA) at 80 and 20 dispensers/ha to the mating disrupted only blocks. One to two aphicide treatments were applied to all trial areas during the study periods.

Another orchard with the size of 2-ha served as a reference treated in a conventional way. It was located near the city of Sliven and established in 2003. Ten to eleven treatments were applied there during each season, to control OFM, PTB and other pests. Eight to nine of them were timed against oriental fruit moth and peach twig borer. The fruit damage by OFM in this orchard in the years 2014-2016 ranged from 5.6 till 6.2 % and by PTB respectively from 2% till 2.7%. The economical threshold by OFM in Bulgaria was 4-6% damaged fruits at harvest time and 2% damaged fruits by PTB.

Indices studied

Monitoring of OFM and PTB flight was carried out by sex pheromone trapping in the years of study. Four PHEROCON® VI Delta, sticky traps was installed in the trial orchard on a scheme provided by the producer. Two traps were baited with a standard OFM L2 Orfamone lures and other two with PTB L2 Anemone lures (Trece Incorporated, USA). The traps were installed before OFM and PTB flights started. For comparison, four PHEROCON® VI Delta sticky traps were installed in a 2 ha reference orchard located in the same region, which was treated with insecticide only. All pheromone traps were checked twice a week.

Data collection and analysis

Damage to shoots was evaluated during the first generation of OFM and PTB on 20 randomly selected trees, within the central area of each block. Correspondingly, fruit damage was recorded on 100 fruits per each selected tree. Therefore, 2000 fruits were inspected for damage from both pests in each block. The rate of damaged fruits in the trial plots were compared with that in the reference orchard, treated with conventional pesticides only, using the same evaluation techniques. Data on the capture of male moths in the pheromone traps were considered as totals for each date of control and presented in a graphical form. The rate of fruit damage by OFM was expressed as a percentage of damaged fruits. Significance of differences in the damage rate between the

trial and reference orchard was estimated by use of Chi-square test.

Results and discussion

OFM flight dynamics

The first flight of oriental fruit moth in the reference orchard in 2014 -2016 began in the third to fourth week of April and finished the second to third week of October (Fig 1). The pest developed 4 generation during the years of study. The traps installed in the reference orchard caught in total 1380 moths in 2014, 1304 in 2015 and 779 in 2016. The population density of OFM decreased season to season due to the new active ingredients used by the grower. In the trial plot, after installation of CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers, no moths were caught in the pheromone traps, indicating a high level of disruption.

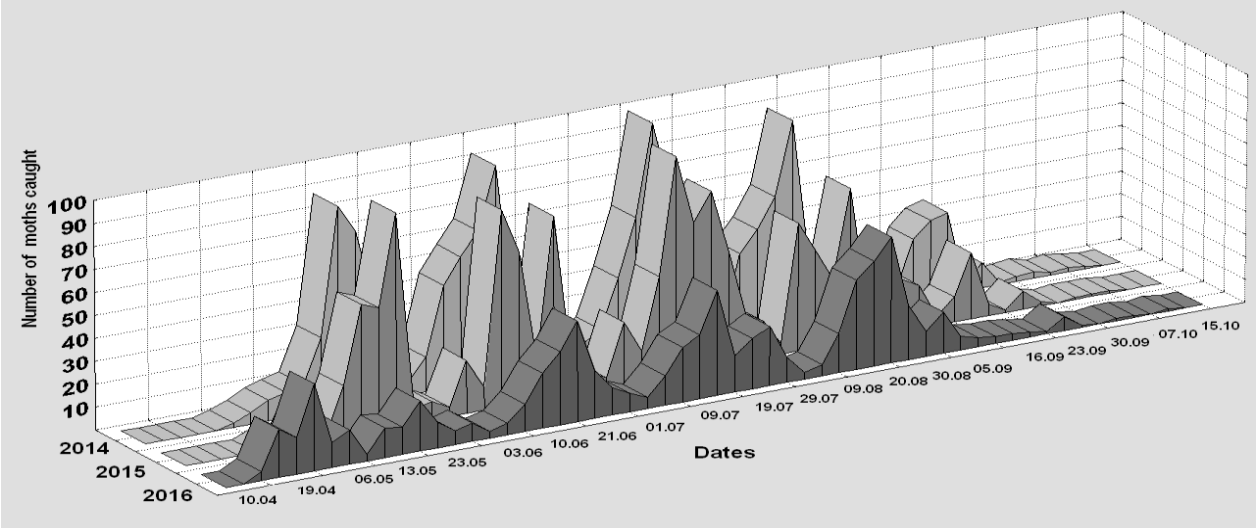

Figure 1. Flight dynamics of OFM in the reference orchard in successive years of study 2014- 2016

PTB flight dynamics

The first flight of peach twig borer (PTB) in the reference orchard in 2014 -2016 began in the fourth decade of April till the first decade of May and finished till the second week of October (Fig 2). The traps installed in the reference orchard caught in total 705 moths in 2014 , 1075 in 2015 and 476 in 2016. PTB developed 3 generation during the years of study.

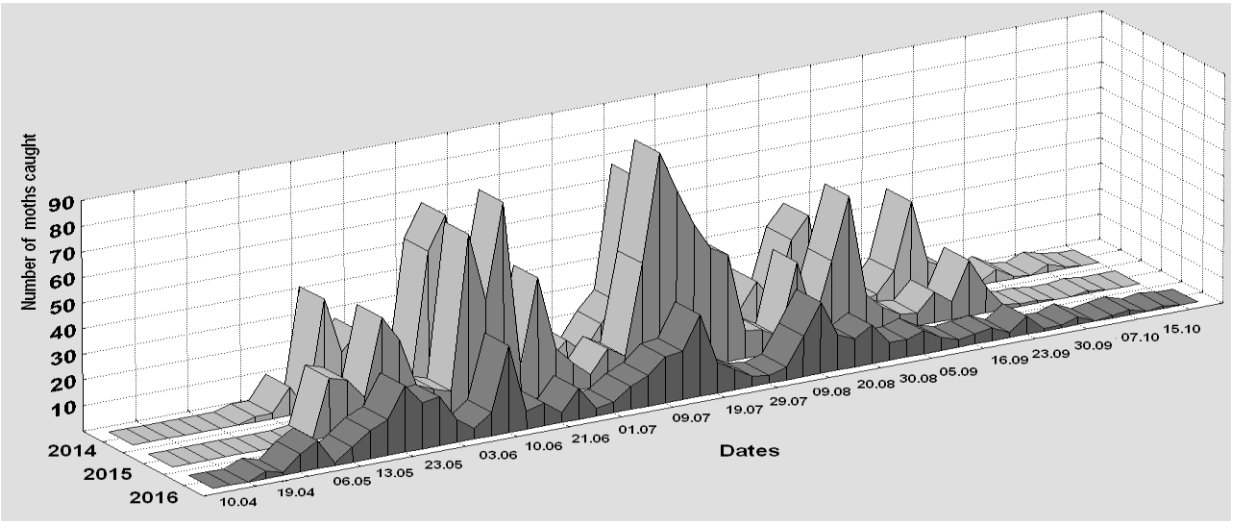

Figure 2. Flight dynamics of PTB in the reference orchard in successive years of study 2014- 2016

Evolution of shoot and fruit damage by OFM during the season

Severe damage of shoots by OFM was noted at the end of May in the reference, conventionally treated orchard, in the years of study (Table 1). At the same time no shots were damaged in the trial plot, where CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers were installed. Damage rates of shoots were significantly different between the treated plots and the reference orchard during the fourth week of May in the successive the years ($p < 0.01$).

First signs of fruit damage were noted in the reference orchard at the end of June of each year. Starting from the end of June, through August and September, the fruit damage rate steadily increased, reaching finally at harvest 5.6% in 2014, 6.2% in 2015 and 5.8% in 2016. In the trial plot only a few damaged fruits were noted at the end of the season; at harvest it was also negligible – 0.1%-0.2% in 2014, 2015 and 2016. Damage rates were significantly different between the treated plots and the reference orchard already on 13 July and August 25 in 2014 , 14 July and August 24 in 2015, 16 July and August 18 in 2016 ($p < 0.01$) and thereafter until harvest in three years of the study ($p < 0.001$).

Damage caused by OFM and PTB was considerable in the reference orchard, in spite of 8-9 conventional treatments applied against OFM and PTB. It is suspected that the population of OFM and PTB in this orchard is already resistant to some of the insecticides used. Resistance of OFM to organophosphate, pyrethroid and carbamate insecticides was detected in Canada (Pree *et al.,* 1998 and Kanga *et al.,* 1999) and was considered as main cause of failure of conventional plant protection. Apparently a similar situation may occur in Bulgarian peach orchards. Application of mating disruption with use CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers of *Trécé* Inc., USA significantly reduced OFM and PTB incidence and damage caused by these pests.

This is in line with the reports from other countries. Positive results of mating disruption of *Cydia* (*Grapholitha*) *molesta*, have been reported from South Africa by (Barnes and Blomefield, 1997) from Italy (Trematerra *et al.,* 2000) and also from Australia (Sexton and Il'ichev, 2000). According to the studies of Molinari *et al.* (2000) efficacy of synthetic pheromones, applied for mating disruption of *C. molesta* and *A. lineatella*, was very high. In 74 tests in 1998 and in 119 tests in 1999 damages were below 1%. In the investigation of Molinari (2007) confusion methods, involving 300-1000 pheromone dispensers per ha, reduced OFM reproduction in peach orchards, provided that the dispensers had been installed before the start of the first flight. They remained effective through the 2nd and 3rd generation of the pest. MD proved also to be effective in control of OFM in peach orchards of Slovenia (Rot and Blazič, 2005) and New Zealand (Lo and Cole, 2007) and indicates that the MD method may be successfully introduced in Bulgarian peach orchards. The present results do confirm that mating disruption, using CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO dispensers, can provide a more effective control of the both important pests on peach - oriental fruit moth and peach twig borer. The usage of CIDETRAK® OFM/PTB and CIDETRAK® OFM/PTB MESO shows that the number of dispensers used does not affect the effectiveness of mating disruption. And the reduced rate of dispensers used will help the growers to decrease labour in the field. Applications of these dispensers can provide an effective control of oriental fruit moth and peach twig borer, with better results than the conventional protection programmes employed in Bulgaria. This approach to controlling oriental fruit moth and peach twig borer is in line with the recent EU recommendations that recommend preservation of the natural environment and production of healthy fruits, with no pesticide residues.

Table 1.Evolution of shoot and fruit damage by OFM in the Cidetrak® OFM/PTB and Cidetrak® OFM/PTB MESO trial plots (T1 and T2) and in the conventionally treated reference orchard (RO) in the successive years of study 2014-2016

Index	Season 2014	Damage (%)			Season 2015	Damage (%)			Seaso 2016	Damage (%)		
		T1	T2	RO		T1	T2	RO		T1	T2	
Shoot Damage (%)	May 21	0	0	9.8	May 20	0	0	9.6	May 19	0	0	10.2
	May 31	0	0	13.8	May 29	0	0	16.7	May 27	0	0	17.5
Fruit Damage (%)	June 17	0	0	0	June 18	0	0	0	June 17	0	0	0
	June 28	0	0	0.6	June 29	0	0	0.8	June 25	0	0	0.6
	July 7	0	0	0.7	July 8	0	0	0.9	July 9	0	0	0.6
	July 13	0	0	1.5	July 14	0	0	1.2	July 16	0	0	1
	July 26	0	0	1.7	July 28	0	0	2.1	July 24	0	0	1.2
	August 25	0	0.1	2.6	August 24	0	0	2.8	August 18	0	0	2.2
	September 9	0.1	0.2	3.5	September 5	0	0.1	3.6	September 4	0	0	3
	September 14	0.1	0.2	5.2	September 10	0.1	0.1	4.8	September 10	0.1	0.1	4
	September 26	0.1	0.2	5.6	September 20	0.1	0.1	6.2	September 18	0.1	0.1	5.8
	At harvest	0.0-0.1	0.0-0.2	0.0-5.6	At harvest	0.0-0.1	0.0-0.1	0.0-6.2	At harvest	0.0-0.1	0.0-0.1	0.0-5.8

Table 2. Evolution of shoot and fruit damage by PTB in the Cidetrak® OFM/PTB and Cidetrak® OFM/PTB MESO trial plots and in the conventionally treated reference orchard in the successive years of study 2014- 2016

Index	Season 2014	Damage (%)			Season 2015	Damage (%)			Season 2016	Damage (%)		
		T1	T2	RO		T1	T2	RO		T1	T2	RO
Shoot Damage (%)	May 21	0	0	1.9	May 20	0	0	2.1	May 19	0	0	2.2
	May 31	0	0	3.8	May 29	0	0	3.9	May 27	0	0	4.2
	June 17	0	0	0	June 18	0	0	0	June 17	0	0	0
	June 28	0	0	1.2	June 29	0	0	1.6	June 25	0	0	1.3
Fruit Damage (%)	July 7	0	0	1.3	July 8	0	0	1.7	July 9	0	0	1.4
	July 13	0	0	1.6	July 14	0	0	1.8	July 16	0	0	1.4
	July 26	0	0	1.7	July 28	0	0	2	July 24	0	0	1.5
	August 25	0	0	1.9	August 24	0	0	2.1	August 18	0	0	1.8
	September 9	0.1	0.2	2	September 5	0	0.1	2.3	September 4	0.1	0.1	2
	September 14	0.1	0.2	2	September 10	0.1	0.1	2.5	September 10	0.1	0.1	2
	September 26	0.1	0.2	2	September 20	0.1	0.1	2.7	September 18	0.1	0.1	2.1
	At harvest	0.0-0.1	0.0-0.1	0.0-2.0	At harvest	0.0-0.1	0.0-0.1	0.0-2.7	At harvest	0.0-0.1	0.0-0.1	0.0-2.1

REFERENCES **226**

Andreadis, S. S., Milonas, P. G., and Michaelakis, A. 2014. Applications of sex pheromones for pest control: the use of mating disruption technique in Greece from 1986 to 2011. *IOBC-WPRS Bulletin*, **99:** 69-73.

Barnes B. N. and Blomefield T.L. 1997. Goading growers towards mating disruption: the South African experience with *Grapholita molesta* and *Cydia pomonella* (Lepidoptera: Tortricidae). *Bulletin OILB/SROP*, **20**(1): 45-56.

Jones, O. 2014. Pheromones and other semiochemicals: Essential tools for IPM. *International Pest Control*, **56**(2): 88.

Kanga, L. H. B., Pree, D. J.; Lier, J. L. and van Walker, G. M. 1999: Monitoring for resistance to organophosphorus, carbamate, and pyrethroid insecticides in the oriental fruit moth (Lepidoptera: Tortricidae). *Canadian-Entomologist*, **131**(4): 441-450.

Kutinkova, H. Y., Veselin A. Arnaudov, Vasiliy Ts. Dzhuvinov. 2015. Sustainable Control of Oriental Fruit Moth, Cydia molesta Busck, Using Isomate OFM Rosso Dispensers in Peach Orchards in Bulgaria. CHEMICAL (Riccardo Guidetti, Luigi Bodria, Stanley Best eds.), *Engineering Transactions* **44**: 1-6.

Lo P.L. and Cole L.M. 2007. Impact of pheromone mating disruption and pesticides on oriental fruit month (*Grapholita molesta)* on peaches. *New Zealand Plant Protection*, **60**:67-71.

Lu, P. F., Huang, L. Q., and Wang, C. Z. 2012. Identification and field evaluation of pear fruit volatiles attractive to the oriental fruit moth, *Cydia molesta*. *Journal of chemical ecology*, **38**(8): 1003-1016.

Mamay, M., Yanık, E., and Doğramacı, M. 2014. Phenology and damage of *Anarsia lineatella* Zell. (Lepidoptera: Gelechiidae) in peach, apricot and nectarine orchards under semi-arid conditions. *Phytoparasitica*, **42**(5): 641-649.

Molinari, F. 2007. Uno strumento a supporto della difesa di pesco, albicocco e susino: l'uso dei feromoni su drupacee contro i lepidotteri carpofagi. *Informatore-Agrario*, **63** (13):53-56.

Molinari, F., Cravedi, P., Rama, F., Reggiori, F., Pane, M. D. and Galassi, T. 2000: L'uso dei feromoni secondo il metodo del "Disorientamento" nella difesa del pesco da *Cydia molesta* e *Anarsia lineatell*a. GF-2000 Atti Giornate Fitopatologiche, Perugia, **16-20** : 341-347.

Natale, D., Mattiacci, L., Hern, A., Pasqualini, E., and Dorn, S. (2003). Response of female Cydia molesta (Lepidoptera: Tortricidae) to plant derived volatiles. *Bulletin of entomological research*, **93**(04): 335-342.

Navrozidis, E., Thomidis, T., Tsipouridis, C., Xatzicharisis, I., Fotiadis, I. and Servis, D. 2005: Pheromone-based communication disruption of *Adoxophyes orana* on peach using the new RAK 3+4 dispensers and their effect on development of fruit rot diseases. *Phytoparasitica* **33**: 149-153.

Öztürk, N., Hazir, A., and Ulusoy, M. R. 2010. Efficacy of mating disruption technique against Peach twig borer, *Anarsia lineatella* Zeller, 1839 (Lepidoptera: Gelechiidae) which is harmful on apricot in Mut District, Mersin Province. *Türkiye Entomoloji Dergisi*, **34**(3), 337-350.

Pree, D. J., Whitty, K. J., Driel, L. and van Walker, G. M. 1998. Resistance to insecticides in oriental fruit moth populations (*Grapholita molesta*) from the Niagara Peninsula of Ontario. *Canadian Entomologist*, **130**(3): 245-256.

Rot M. and Blazič, M. 2005. Zatiranje breskovega zavijaca (*Cydia molesta* L.) z metodo zbeganja. Lectures and

Papers-Presented at the 7th Slovenian Conference on Plant Protection, Zrece, Slovenia, 8-10-March 2005:175-181.

Rothschild, G. H. L. 1975. Control of oriental fruit moth (*Cydia molesta* (Busck)(Lepidoptera, Tortricidae)) with synthetic female pheromone. *Bulletin of Entomological Research*, **65**(03): 473-490.

Sexton S.B. and Il'ichev, A.L. 2000. Pheromone mating disruption with reference to oriental fruit moth *Grapholita molesta* (Busck). (*Lepidoptera:Tortricidae*) literature review. *General and Applied Entomology* **29**:63-68.

Trematerra P., Sciarretta, A. and Gentile P. 2000. Trials on combined mating disruption in *Anarsia lineatella* (Zeller) and *Cydia molesta* (Busck) using CheckMateReg. SF dispenser. *Atti Giornate Fitopatologiche Perugia*, 349-354.

Vickers, R. A., Rothschild, G. H. L., and Jones, E. L. (1985). Control of the oriental fruit moth, *Cydia molesta* (Busek) (Lepidoptera: Tortricidae), at a district level by mating disruption with synthetic female pheromone. *Bulletin of Entomological Research*, **75**(04): 625-634.

Hristina Kutinkova[1*], Stefan Gandev[1], Vasiliy Dzhuvinov[1], Bill Lingren[2]

[1]Fruit Growing Institute, "Ostromila" 12, 4004 Plovdiv, Bulgaria
Tel: 359 32 692349 ; Fax: 359 32 670808
[2]Trécé Inc., Adair OK, USA
*Correspondence author
E-mail: kutinkova@abv.bg