Control of codling moth, *Cydia pomonella* with CIDETRAK® CM MEC and CIDETRAK® CM + CIDETRAK® DA MEC liquid formulations in Bulgaria

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Abstract

The codling moth (CM) Cydia pomonella *L. (Lepidoptera: Tortricidae) is the major pest of apple worldwide. Recently CM has developed resistance to organophosphates and other commonly used insecticides, that have been the major tools used for control of this pest historically. Reduction of pesticide use is an important issue for human health as well as for conservation of biodiversity. Environmentally friendly methods such as microencapsulated semiochemicals including pheromones and kairomones are among the most promising. The aim of this study was to test the effectiveness of microencapsulated pheromone mating disruption in apple orchards using CIDETRAK® CM MEC (pheromone) liquid formulation for control of codling moth (CM) and CIDETRAK DA MEC (kairomone) for enhancement of CM MEC for adult control and insecticide applications for larval control. The trials were carried out during the years 2018 and 2019 in the South East region of Bulgaria. Monitoring of CM flights was implemented using pheromone or pheromone and kairomone lures with traps during the years of the study. Traps were baited with standard PHEROCON® CM L2 – codlemone lures, which were changed at 8 week intervals. We also used PHEROCON® CM DA COMBO + AA lures and separately PHEROCON® CM DA COMBO - P + AA lures, which are new products developed by Trécé Inc., USA for the orchards with MD during the years of study.*

The damage in the trial plot increased slowly with time and even in late cultivars, fruit damage by CM was below the economical threshold – from 0.0 to 0.2% in both years of the study. Comparatively, ten insecticide treatments were applied to the reference orchard during the season, to control CM and other pests. Correspondingly, fruit damage, in this orchard, by CM was from 1.2 to 3.6%. The significance of differences in the damage rate between the trial and the reference orchard was estimated by the use of Chi-square tests.

These new products developed by Trécé Inc., USA can be used in Organic Farming and fits perfectly into any IPM system. The use of CIDETRAK® CM MEC used alone or enhanced by CIDETRAK® DA MEC will help growers to decrease the number of chemical treatments in the field. Introduction of these products for pest management should result in reduction of the use of conventional chemical insecticide treatments, thus resulting in reduction of environmental pollution and improved food quality.

Keywords: codling moth, apple, mating disruption, CIDETRAK® CM MEC, CIDETRAK® DA MEC

Introduction

The codling moth (CM) *Cydia pomonella* L. (Lepidoptera: Tortricidae) is the major pest of apple worldwide. Its larvae feed internally within the fruits and cause severe damage to apples, pears, quinces, and walnuts in Bulgaria. Till the present time it has been controlled by routine applications of a broad spectrum of insecticides, such as organophosphates, to maintain this pest at an economically acceptable level. Recently CM has developed resistance to organophosphates and other commonly used insecticides, that have been the major tools used for control of this pest historically. (Knight, 2010, Pajač et al., 2011; Reyes

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et al., 2015; Bosch et al., 2018). The presence of strong insecticide resistance was reported for codling moth strains collected from some orchards in Bulgaria (Charmillot et al. 2007). In spite of numerous chemical treatments, these orchards show increasing flight densities of CM moths, growing populations of hibernating larvae, and rising fruit damage rates. Reduction of pesticide use is an important issue for human health as well as for conservation of biodiversity. Environmentally friendly methods such as microencapsulated semiochemicals including pheromones and kairomones are among the most promising.

Objectives

The aim of this study was to test the effectiveness of microencapsulated pheromone mating disruption in apple orchards using CIDETRAK® CM MEC (pheromone) liquid formulation for control of codling moth (CM) and CIDETRAK DA MEC (kairomone) for enhancement of CM MEC for adult control and insecticide applications for larval control**.** These products were developed and are manufactured by Trécé Inc., USA.

Materials and methods

The trials were carried out during the years 2018 and 2019 in the South East region of Bulgaria. Monitoring of CM flights was implemented using pheromone or pheromone and kairomone lures with traps during the years of the study. PHEROCON® VI Delta, sticky traps were installed in the trial orchard using a scheme provided by the producer. All traps were installed before CM flights started. Traps were baited with standard PHEROCON® CM L2 – codlemone lures, which were changed at 8 week intervals. We also used PHEROCON® CM DA COMBO + AA lures and separately PHEROCON® CM DA COMBO - P + AA lures, which are new products developed by Trécé Inc., USA for the orchards with MD during the years of study. These lures were also changed at 8 week intervals. PHEROCON® VI Delta sticky traps baited with PHEROCON CM COMBO + AA lures and standard CM L2 caps were installed, for comparison, in a reference orchard located nearby. This orchard was treated with insecticides only in 2018 and with insecticides and CIDETRAK DA MEC in 2019. All pheromone traps were checked twice per week and sticky liners changed at 4 week intervals in all traps, in all treatments in both years of the study.

CIDETRAK® CM MEC is a flowable formulation of microencapsulated CM pheromone, which we applied for mating disruption as an addition to an insecticide treatment regimen. Accordingly, CM MEC was tank mix with the insecticide designated for application at the recommended time interval within a series of insecticide treatments.

CIDETRAK® CM MEC was used in the experimental orchard tank mix with insecticide treatments in 2018. Furthermore, CIDETRAK® CM MEC was used on half of the trial orchard, while the other half was treated CM MEC + DA MEC to enhance the CM MEC and insecticide activity in 2019. The insecticides used are emamectin benzoate and rynaxypyr. Accordingly, the products were tank mix with insecticides and used at recommended, timely intervals in the series of insecticide treatments. The damage to apples was inspected during the season and at harvest on 2000 fruits.

Results and discussion

In the figures below are presented the flight dynamics of codling moth in the trial orchard in 2018 and 2019 (Fig. 1, 2,3,4). The pest developed 2 full generation during the years of study.

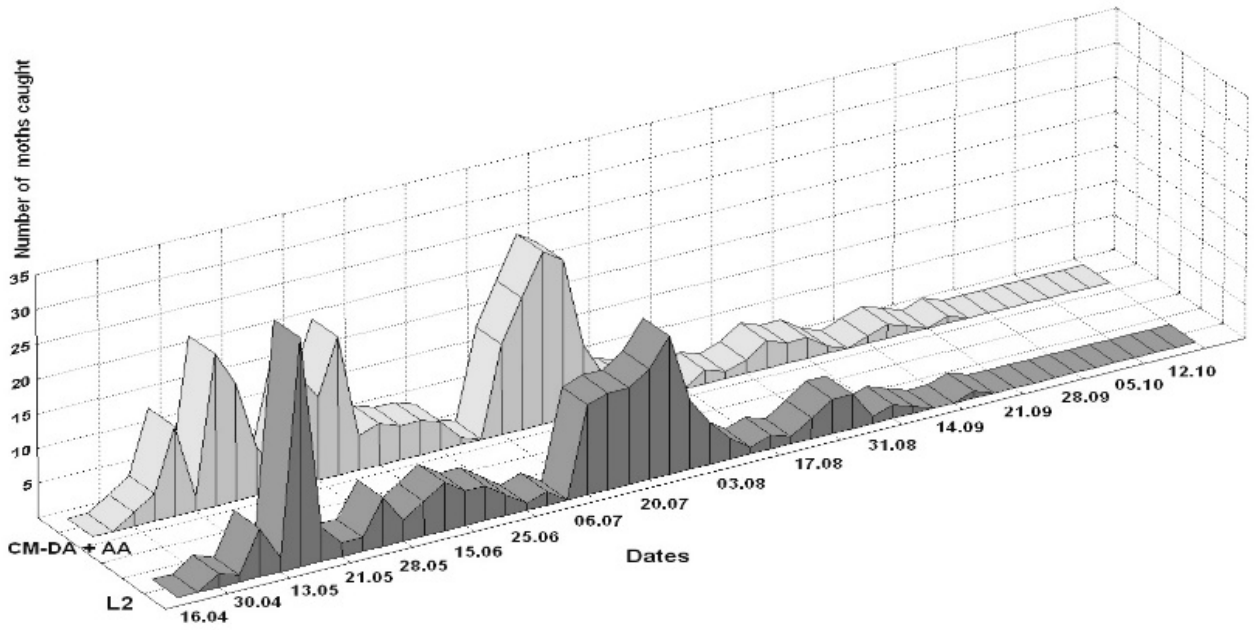

Figure 1. Flight dynamics of codling moth with CM /DA + AA lures and L2 caps in the experimental plot treated with insecticides only in 2018 in Sliven region

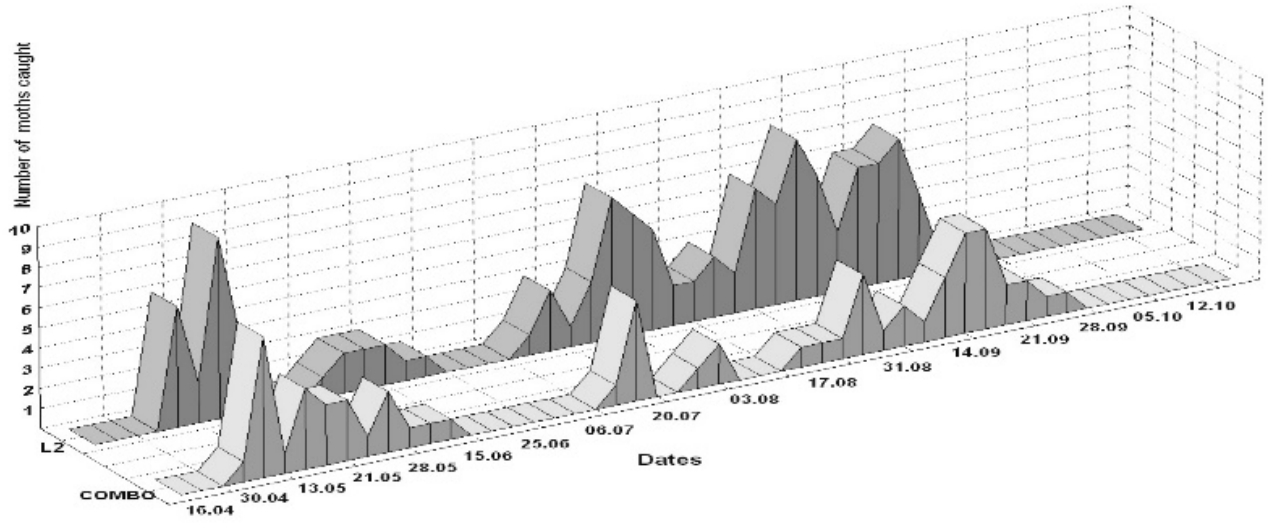

Figure 2. Flight dynamics of codling moth with CM /DA + AA lures and L2 caps in the experimental plot treated with insecticides and CM MEC in 2018 in Sliven region

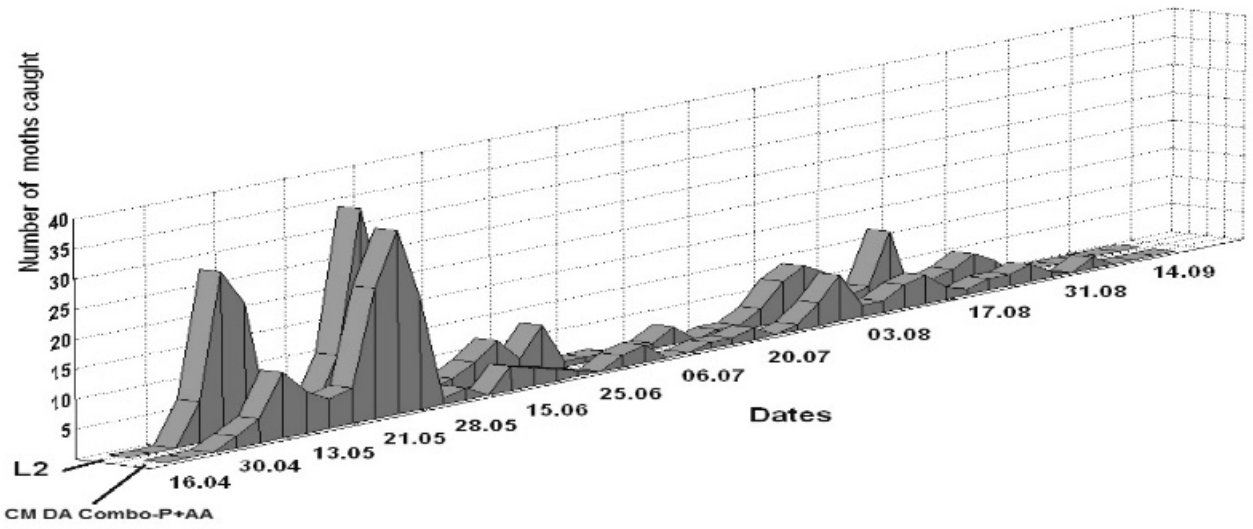

Figure 3. Flight dynamics of codling moth with CM DA Combo-P + AA lures and L 2 caps in the experimental plot treated with insecticides + DA MEC in 2019 in Sliven region

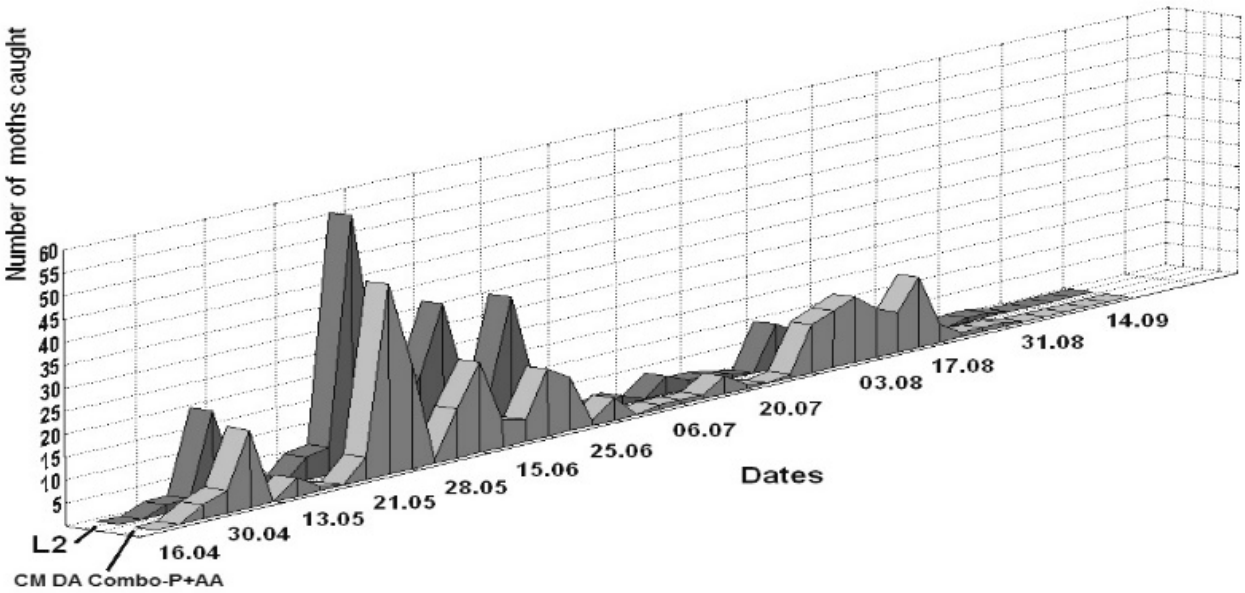

Figure 4. Flight dynamics of codling moth with CM DA Combo - P + AA lures and L2 caps in the experimental plot treated with insecticides CM MEC and CM MEC + DA MEC in 2019 in Sliven region.

The results with CIDETRAK® CM MEC and CIDETRAK® CM MEC + DA MEC in the trial apple orchard was positive. Correspondingly, fruit damage in the trial plot was compared with that in a reference orchard, which was located nearby and treated with conventional insecticides without CIDETRAK CM or CIDETRAK CM + DA MEC. The grower made only 4 treatments per season, in the MEC treated plots, in both years of this study.

The damage in the trial plot increased slowly with time and even in late cultivars, fruit damage by CM was below the economical threshold – from 0.0 to 0.2% in both years of the study. Comparatively, ten insecticide treatments were applied to the reference orchard during the season, to control CM and other pests. Correspondingly, fruit damage, in this orchard, by CM was from 1.2 to 3.6%. The significance of differences in the damage rate between the trial and the reference orchard was estimated by the use of Chi-square tests.

Conclusions

The present results confirm that, CIDETRAK® CM MEC MD added to the grower insecticide program as a timed tank mix increases the effectiveness of the insecticide program for adult control. Furthermore, CIDETRAK® DA MEC (kairomone) enhances the activity of CM MEC MD (pheromone only) for adult MD and enhances the related insecticide treatments against CM larvae when combined in a tank mix at timed intervals in an insecticide treatment series. Correspondingly, these mixtures can provide more effective control compared to insecticide treatments alone. Notably, timely tank mixes of CIDETRAK® DA MEC and insecticides enhanced the activity of CIDETRAK® CM MEC and the insecticides such that the fruit damage in the experimental plot reached only 0.1 %. Accordingly, these data show that growers may potentially save 5 to 6 insecticide treatments and reduce damaged fruit below the economic threshold level. These new products developed by Trécé Inc., USA can be used in Organic Farming and fits perfectly into any IPM system. The use of CIDETRAK® CM MEC used alone or enhanced by CIDETRAK® DA MEC will help growers to decrease the number of chemical treatments in the field. Introduction of these products for pest management should result in reduction of the use of conventional chemical insecticide treatments, thus resulting in reduction of environmental pollution and improved food quality.

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