Use of Carpovirusine for Control of Codling Moth, *Cydia pomonella* L. (Lepidoptera: Tortricidae), in Bulgaria Progress Report

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ABSTRACT

The trials were carried out in Central-South Bulgaria in 2006 and 2007. In a conventionally managed reference orchard, sixteen chemical treatments were applied during the season. Fifteen of them could act against codling moth larvae. In spite of that, fruit damage by CM reached at harvest 6.8 in 2006 and 18.7 in 2007. At the same time damage in the plot, treated twelve times with GpGV, was only 0.05% in 2006 and 0.4% in 2007. The overwintering population in the plot treated with GpGV was 0.125 larvae per tree in autumn 2006 and 0.175 larvae per tree in 2007, whereas in the reference orchard 3.32 larvae per tree in autumn 2006 and 7.97 in 2007. The high fruit damage and overwintering CM indicate the population to be resistant tothe organophosphates used. Positive results obtained with Carpovirusine show that it may be effective as a means of biocontrol of CM in Bulgaria.

Keywords: codling moth, flight-dynamics, overwintering-larvae, granulosis-virus, CpGV

INTRODUCTION

The codling moth (CM), *Cydia pomonella* L. (Lepidoptera: Tortricidae) is a major pest of fruit orchards worldwide. In Bulgaria it is currently controlled in apple orchards by conventional spray applications, mainly with organophosphates. Intensive use of chemical pesticides, especially ofthe same group, leads to development of resistant CM strains (Charmillot *et al*.,1999). Such resistance is successively increasing and even cross-resistance to new pesticides may appear (Charmillot and Pasquier, 2002). Recently strong resistance to organophosphates and pyrethroids has been revealed in the strains of codling moth from Bulgarian apple orchards (Charmillot *et al*., 2007).

In order to overcome the problems of resistance and to avoid contamination of fruit products with pesticide residuces, novel methods of biological control of codling moth have to be elaborated. A possible solution of this problem represents the codling moth granulosis virus, CpGV (Charmillot and Pasquier, 2003). CpGV was first isolated in Mexico 44 years ago (Tanada, 1964). Numerous experiments have shown that CpGV is efficient against colding moth (Glen and Payne, 1984). A commercial product, Carpovirusine, produced by Natural Plant Protection unit (N.P.P.) a subsidiary of Arysta Life Science, has been registered in France since 1993 (Biache *et. al*., 1998a) Soon after registration the product exhibited positive effects in control of codling moth (e.g. Biache *et.al*., 1998b, Pluciennik *et.al*., 1999). Regarding the difficult insecticide resistance situation in Bulgaria the tests of Carpovirusine for control of codling moth were undertaken in this study.

MATERIAL AND METHODS

The 2-ha commercial orchard, used for testing Carpovirusine is located in the village Kalekovee, Plovdiv region, Central-South Bulgaria. It was established in 1994 with the cultivars Jonagold, Florina and Granny Smith. Carpovirusine was applied, there at the dose of 1 litre per ha (1.10^{13} granules per ha), twelve times during the season, five times against the first and seven times against the second generation of codling moth, at 10-12 day intervals, as suggested by Stara and Kocourek (2003).

Another orchard of the Plovdiv region, with an area of 1.8 ha, served as a reference with conventional managenent in 2006 and 2007. Sixteen conventional pesticide treatments, including fenitrotion, triflumuron, cipermetrin and clorpyrifos-ethyl, were applied there during each season to control CM, leaf miners, leaf rollers, aphids and mites; fifteen of them were supposed to have an action against CM larvae.

In both years of study, for monitoring of CM flights, two standard pheromone traps were installed in the centre of the plot treated with Carpovirusine as well as in the reference orchard, before the flight started: The triangular delta traps baited with a standard pheromone dispenser capsule (Pheronet OP-72-T1-01), containing 1 mg codlemone. All traps were checked twice a week. For evaluation of damage caused by CM, samples of 1000 or 2000 fruits were examined in the trial plot and in the reference orchard during season. Preharvest evaluation of damage was carried out on 3000 fruits in each orchard. In June of each year of study, corrugated cardboard band

traps were placed on tree trunks in the trial plot (4 at the border and 16 inside) as well as 40 bands in the reference orchard. They were recovered in autumn, after harvest, and the diapausing CM larvae were counted.

RESULTS AND DISCUSSION

In 2006, the first flight in the reference orchard began on 26 April and reached its maximum by the second decade of May (Figure 1a). The flight of the second generation, which overlapped the first one, started at the end of June, reached its maximum in the third decade of July, continued with varying intensity in August and finished on the 17th of September. The traps in the reference orchard caught 146 moths during the whole season. In the virus treated plot at Kalekovec followed a similar trend, albeit was less intense. Two standard pheromone traps caught in total only 32 moths there.

In 2007, the first catches of CM males were noted on April 10, then the flight successively intensified to reach its maximum by the second decade of the month (Figure 1b). Later on, a considerable flight peak appeared in the second decade of May. The flight of the second generation, which did not overlap the first one in 2007, started at the beginning of July, reached its maximum in the second decade of the month and then declined. However, additional flight peak appeared in the third decade of August. The CM flight finished on 19 September. Traps in the reference orchard caught 291 moths during the whole season. In the virus treated plot at Kalekovec CM flight was very weak and standard pheromone traps caught only 36 males in total; 11 of them before the first application of Carpovirusine.

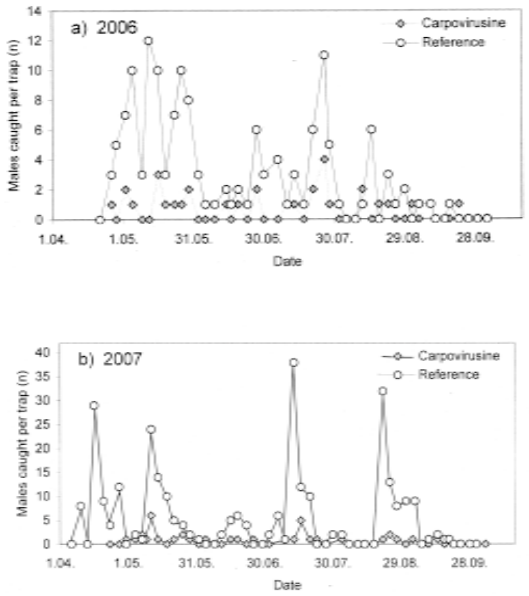

Figure 1. Seasonal flight of CM as males caught per pheromone trap at half-week intervals in the Carpovirusine treated plot and in the reference orchard in 2006 and 2007

In 2006 no fruit damage by codling moth larvae was noted in the Carpovirusine treated plot till the beginning of August. Later on very few damaged fruits were found at harvest the damage rate was still only 0.05% (Table 1). In the reference orchard, treated with conventional insecticides, some fruit damage appeared as early as in June and successively progressed, reaching 6.9% at harvest. Infestations rates were significantly different between the treated plot and the reference orchard from July on until harvest (Chi-square test, $P<0.001$).

In 2007 the damage in the Carpo virusine treated plot also appeared quite late in season and at a very low rate, reaching 0.4% at harvest. Fruit damage in the reference orchard was higher in the second year of study than in the first year. In spite of numerous pesticide treatments applied, damaged by CM amounted to 18.7% at harvest, thus causing serious economic losses. Except for the sampling at 2nd June and 5th July 2007, infestation rates were significantly different between the the treated plot and the reference orchard from July on until harvest (Chi-square test, $P<0.001$).

In the Carpovirusine treated plot at Kalekovec only very few diapausing codling moth larvae were found under corrugated paper bands after harvest in 2006 (0.125 larvae per tree) as well as in 2007 (0.175 larvae per tree). This result matches very well both the low mid - season damage rates as the few infested fruit at harvest. In contrast, in the reference orchard, located in the same Plovdiv region, treated fifteen times with chemical insecticides against codling moth per year, showed a considerable overwintering population in 2006 (3.32 larvae per tree) and even increasingly high number of CM in 2007 (7.97 larvae per tree).

Such population increase in only one year and under intensive insecticide treatement applied pinpoints the considerable resistance problems in the region (Charmillot *et al.*, 2007). Increasing resistance of codling moths result ineffictiveness of classical control programs and in increasing population of the pest in the conventionally treated apple orchards. Granulosis virus (CpGV), applied in form of carpovirusine 2000 may be helpful in overcoming the problem of resistance of CM to pesticides. As shown in the present study, this product, applied at short intervals of about 10-12 days (Stara and Kocourek, 2003), may almost completely prevent fruit damage by CM and may reduce its population considerably. Use of the virus products instead of chemical pesticides should therefore favour protection of the environment in the orchards and

Table 1. Percentage of fruits damaged by codling moth larvae in the Carpovirusine trial plot and in the reference orchard at successive dates in two seasons

2006			2007		
Date	Carpovirusine trial plot	Reference orchard	Date	Carpovirusine trial plot	Reference orchard
June 1	0	0.2	June 2	0	0.2
June 19	0	0.8	June 23	0	21.3
			July 5	0	0
July 31	0	2.3	July 27	0.05	2.7
August 8	0	2.5	August 10	0.05	4.7
August 22	0.2	3.3	August 31	0.1	11.2
September 28	0.05	5.9	September 27	0.4	17.4
at harvest	0.05	6.8	at harvest	0.4	18.7

their surroundings both as prevent contamination of fruit products and thereby improving human health conditions.

ACKNOWLEDGEMENTS

This study was supported by the Swiss National Science Foundation in the frame of the SCOPES programme, under the Project No. IB73A0-110978. Carpovirusine for the trials was provided by Arysta LifeScience, Europe Development Department, Noguéres, France.

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