

Madex Plus and Madex I12 overcome Virus Resistance of Codling Moth

D. Zingg¹

Abstract

*Over the past three years, codling moth populations with resistance to the Mexican isolate of *Cydia pomonella* Granulovirus (CpGV) have been found in Germany, France, Italy, Switzerland and the Netherlands. Andermatt Biocontrol has tested two new virus isolates (Madex Plus and Madex I12) which can overcome CpGV-resistance, and compared them in the field. Both isolates proved effective against Mexican isolate resistant codling moth populations, in several locations. In Switzerland, Madex Plus has been already approved for use.*

Keywords: Codling moth, granulovirus, resistance

Introduction

Since the discovery of the first virus resistance codling moth populations in Germany in 2004, around 35 virus resistant populations have been found (Fritsch et al., 2005). This resistance is against the Mexican isolate of CpGV (M), which is the active agents of all CpGV products on the European market. Many of the sites affected with resistance are in Germany, but there are also some in France, Italy, Switzerland and Holland. No correlation was found between the resistance and the mode of use of the virus products (splitting – full dose) or the length of time of virus application (number of generations treated). A fruit grower could have resistance develop in moths on one plot but not on another similarly treated plot. Resistance was not found on tall trees, not even if these grew adjacent to a plot with resistant moth populations. Resistance was initially only found in organic orchards, but has since also been found in Integrated Pest Management (IPM) orchards.

Laboratory tests showed that the virus resistance of moth populations is a dominant hereditary trait and that the gene responsible is located on the sex chromosomes (Asser et al., 2007). Theoretically, it could spread relatively fast however, in the field the situation does not seem to be so bad. There are orchards that have been treated with viruses for more than 20 years without any signs of moths developing resistance. This is most probably due to the many natural mortality factors present. An EU project showed that granulovirus causes different immune responses in virus resistant compared to non-resistant codling moths. The actual mechanism behind the resistance remains unclear though (for further information see: www.sustaincpgv.eu).

Recently, Andermatt Biocontrol has developed Madex Plus, which can overcome CpGV-resistance. Madex Plus was found through laboratory selection of a virus isolate from larvae of a resistant codling moth population. A novel CpGV-isolate (CpGV-I12), originating from Iran, has been shown to kill efficiently CpGV-resistant larvae (Jehle et al., 2006). In 2007, both isolates were propagated, formulated and field tested by *Andermatt Biocontrol*. Some results of these experiments are reported here.

¹ Andermatt Biocontrol AG, CH 6146 Grossdietwil, zingg@biocontrol.ch

Material and Methods

Trial design: The trials were conducted in a large plots design on one to three varieties in organic orchards with proof of CpGV-M resistance. Madex Plus and Madex I12 were compared to an untreated control.

Application: The applications were carried out by the farmers following the recommendations of the advisory services using full (100 ml/ha) or half (50 ml/ha) dose rates. 7-10 treatments were applied.

Efficacy assessment:

Damage assessment: Two assessments of the damage of codling moth (Cm) in June and before harvest were carried out. Five classes of damage were distinguished:

- Cm stopped: superficial damage of a depth of maximum 5 mm, no larva found
 - Cm stopped, deep: deep damage still stopped before entering the core of the apple, no larva found
 - Cm alive L1/L2: living larvae of first and second larval instar (which did not yet enter the core of the apple)
 - Cm alive L3+: living larvae of third to fifth larval instar having entered the core of the apple
 - Cm complete damage: deep damage including the core of the apple, but no larva found
- Population control

Population assessment: Overwintering larvae in corrugated cardboards around the trunk were counted. 10-40 corrugated cardboards were fixed around the trunk in June and taken away in October/November. Living codling moth larvae in the cardboards were counted.

Results

Madex Plus and Madex I12 overcome resistance

In 2007, a number of field trials were carried out with Madex Plus in orchards with virus resistant as well as non-resistant codling moth populations. The effect of Madex I12 was also tested. The results were largely positive. The results of one such test carried out in Heilbronn (Germany) are shown here as an example (see Figs. 1–3). Both virus isolates, Madex Plus and Madex I12, had more or less the same efficacy.

Aside from these numerous tests, Madex Plus has been already used successfully in Germany in 2007 on a large scale on plots with moth resistance problems. This was made possible thanks to an approval by the Federal Office of Consumer Protection and Food Safety (Plant Protection Act, article 11.2: Risk of delay).

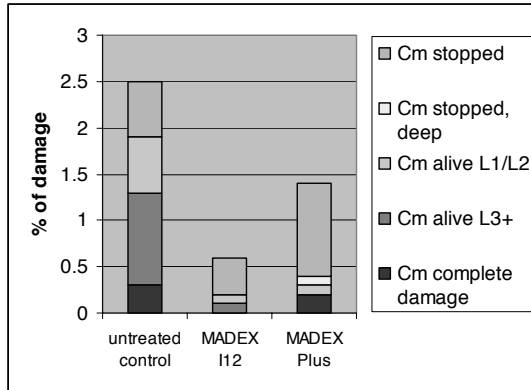


Figure 1: Codling moth (Cm) damage on 21.06.07 on the variety Topaz in an orchard with codling moth virus resistance, close to Heilbronn (DE), after 5 treatments with either Madex Plus or Madex I12. Five different damage categories were defined.

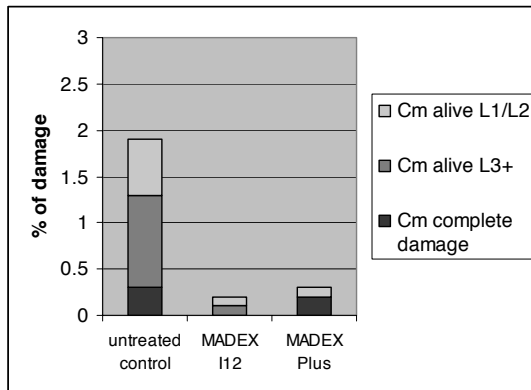


Figure 2: Codling moth (Cm) damage on 21.06.07 on the variety Topaz in an orchard with codling moth virus resistance, close to Heilbronn (DE), after 5 treatments with either Madex Plus or Madex I12. In comparison with figure 1 only 3 damage categories are presented.

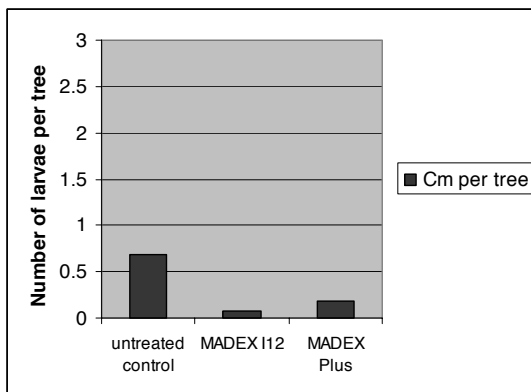


Figure 3: Codling moths (Cm) caught in the trap bands around the trunk in mid October. The data are from the same orchard close to Heilbronn.

Application strategies and anti-resistance management

Since resistance can also develop against new virus preparations, it is wise to use an anti-resistance strategy. What does this mean? Available control measures against codling moth should be used in combination and there should be a strategy for their use. IPM farmers should make use of a combination of mating disruption, virus treatment and chemical control measures. Organic farmers have less of a choice. Therefore, it is especially important for these growers that codling moth populations are kept at low densities to obtain optimal conditions for the use of mating disruption besides the virus applications. If codling moth populations are already high, applications with insect-parasitic nematodes in autumn can help (see Fig. 4).

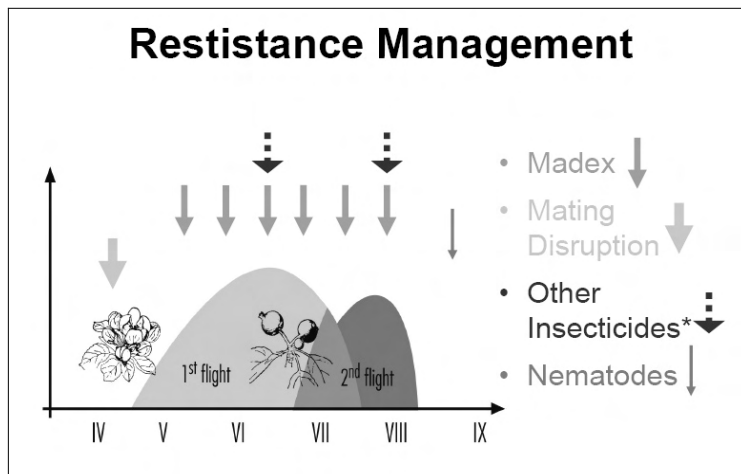


Figure 4: Resistance-Management: The ideal control is a combination of different measures.

* In Switzerland the spinosad product Audienz is listed for the use in organic farming.

Future prospects

The granulovirus resistant moth populations problem is not worrying because, aside from the two virus isolates described above, three more isolates have been identified that can overcome the resistance. Andermatt Biocontrol will try to get permits for Madex Plus or Madex I12 for all countries with moth resistance problems. In Switzerland, Madex Plus is already registered for plant protection. This was obtained in October 2007.

Acknowledgements

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