Codling moth populations less susceptible to CpGV: What about higher concentrations?

Minderempfindlichkeit des Apfelwicklers gegenüber CpGV: Kann durch eine Erhöhung der Aufwandmenge die Wirksamkeit verbessert werden?

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Abstract

In an organic orchard with a codling moth (CM) population less susceptible to CpGV it was tested, whether an increased dosage of CpGV by factor 10 would result in any increased efficacy.
The applications were set in shorter than weekly intervals with 10 ml/ha Madex (low dosage plot) and 100 ml/ha Madex (high dosage plot). The higher dosage showed also a better efficacy, especially on the "active damage" (live larvae).
The orchard where the experiments were conducted was known to have a less susceptible CM population (2004) although there were no serious CM problems reported by the farmer despite the CM control was done only with CpGV. It was investigated, whether natural antagonists might have been a reason for the absence of serious problems in this orchard. No signs of a strong presence of other antagonists were found but CM the population was increasing very much in the year the experiment was conducted (2005). Thus, probably the reason for the absence of CM problems seems to be just a delayed increase of the CM population after the development of a lower susceptibility of CM against CpGV.

Keywords: *Cydia pomonella*, codling moth, granulovirus, susceptibility

Introduction

For a considerable time, the codling moth granulovirus (CpGV) is the main control agent for codling moth (CM) in organic fruit growing. In Germany, since 1999/2000, several growers use also the mating disruption technique in combination with CpGV. In 2002, one organic farmer in Southern Germany near the Swiss Border complained about problems with Codling moth (infestation more than 50 %) that he could not solve even with the combination of CpGV and mating disruption. In the frame of a study of the long-term effects of CpGV, it was planned to compare the susceptibility of CM populations of "old" organic orchards with a long history of CpGV-treatments with a population from IPM-orchards that had not been treated many times before. In 2003, populations from this orchard in Baden, one orchard near Lake Constance (with a long history of CpGV-treatments) where 2003 some infestation could be found, and one IPM orchard were compared. The population from the orchard in Baden was by 10^3 times less susceptible to CpGV than the IPM-population and the laboratory strain. The population from the organic orchard near Lake Constance, as a great surprise, also revealed to be less susceptible to CpGV by factor 10^2 (Fritsch et al., 2004).
Even in 2004, the owner of the orchard near Lake Constance did not complain about CM problems. The population was rather high (but still under 5 %) in 2003 which was attributed to an unsufficient control strategy during a year with very high infestation of CM, did not rise at all in 2004 and seemed to be controlled rather good by the usual strategy of this grower: Treatments with CpGV.

Formatiert: Nummerierung und Aufzählungszeichen

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From these observations, several questions arose:

- Why does the CM population in this orchard not increase like the population in Baden? Are there perhaps natural insect pathogens involved that play a "synergistic" role with CpGV in the field?

- Are treatments with higher doses of CpGV in an economically possible frame still more effective on such populations than lower dosed treatments or should the doses also in the field be enhanced for more than 10^2 as in the laboratory test to see an effect?

To answer these questions, in 2005 a field trial with two different doses of CpGV was conducted in this orchard.

Material and Methods

The orchard is situated near a pasture for horses with some high, untreated apple trees . At the other part there is another organic apple orchard, at the front part there is a little street with a creek behind. The apple cultivars are "Pilot" and "Cybele" planted in 1992. The trees of "Pilot" are much higher than of "Cybele" and showed always a slightly higher infestation of CM.

The applications were done by the farmer himself. At the beginning of the season, he used lower dosage than recommended in both plots because he could not believe a higher dosage would be needed. When the increase of population was evident at the second assessment date, he used a higher dosage and shorter application intervals (Table 1).

Table 1: Treatments with Madex in the low and high dosage plots during the season

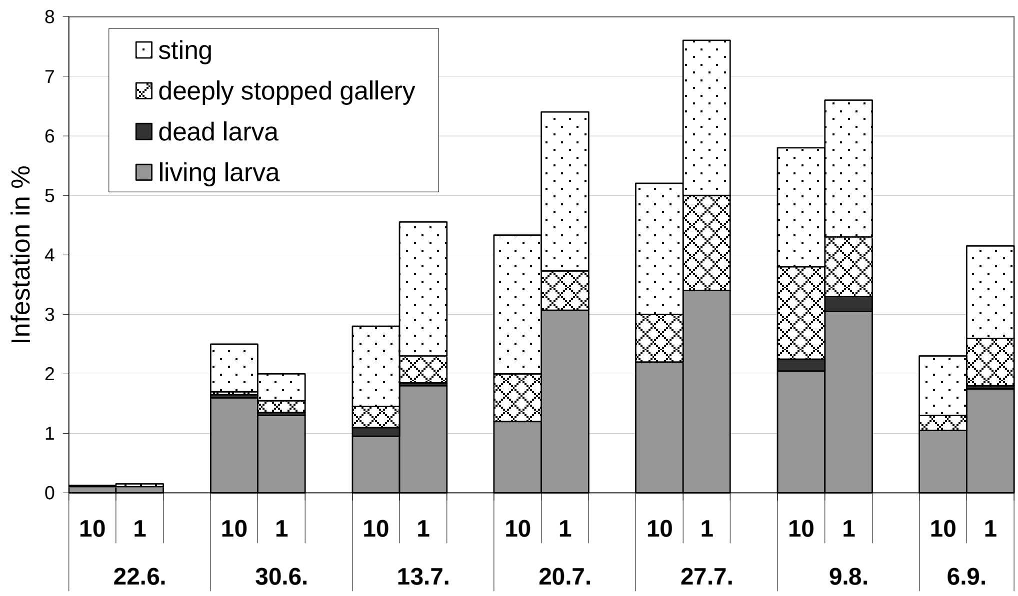
Application date	**Dosage (in ml MADEX/ha)**	
	low dosage plot	high dosage plot
10.6.05	5	40
25.6.05	5	50
02.7.05	10	100
05.7.05	10	100
08.7.05	10	100
13.7.05	10	100
16.7.05	10	100
22.7.05	10	100
29.7.05	10	100
04.8.05	10	100
12.8.05	10	100
19.8.05	10	100
25.8.05	10	100

The plot treated with low dosage consisted of 6 rows of "Pilot", the 7th row was treated from both sides differently, the row 8 and 9 and the rest of the plot was treated with high dosage. Row 10-22 were "Cybele", row 23-24 are "Pilot" again.

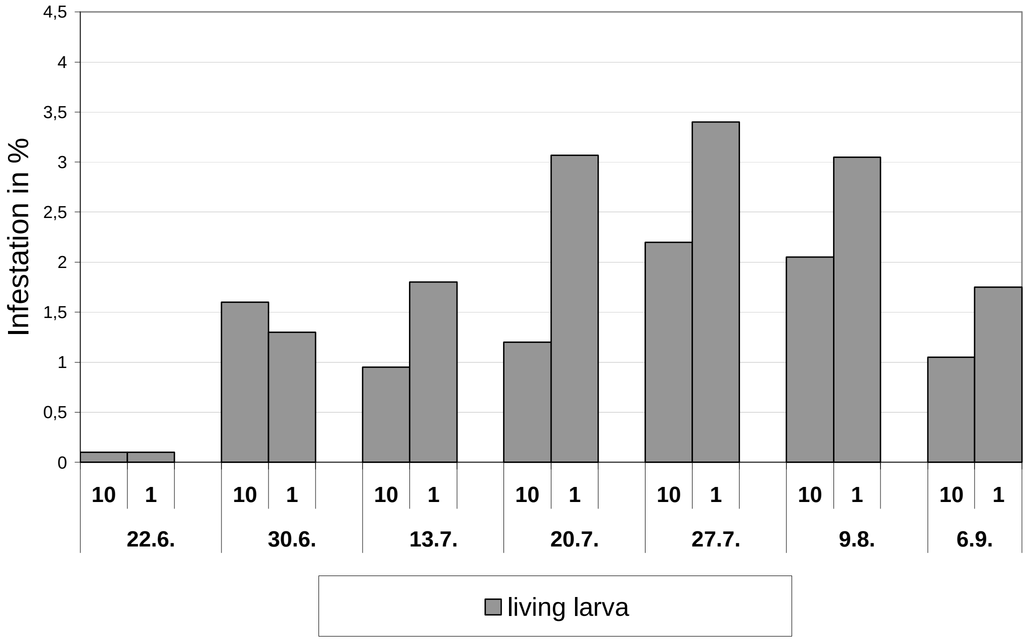
In these two rows the infestation pressure was evidently lower. Thus, only the data of the rows 8 and 9 of the high dosage plot and the rows 4 and 5 of the low dosage plot are reported here to exclude any effect of position on the degree of infestation.
In each row, 1000 fruits were controlled (2000 fruits evaluated per plot). Since it was of interest whether the larvae die after having entered the fruit, the infested fruits were collected during the assessment and put individually in little plastic pots. On each pot it was noticed whether the feeding site was looking “fresh” or “old”. The pots were kept in the laboratory until the fully grown larvae started leaving the fruit for pupation. In the assessment, each fruit was cut open to observe the feeding gallery. In fruits with unfinished galleries the galleries were observed under the stereomicroscope to look for live or dead larvae. To assure that no dead larvae got lost, a part of the infested fruits were opened the day after the assessment under the stereomicroscope.
For the second generation (last assessment date) the infested fruits were separated in fruits with “fresh” frass and fruits with “old” frass. All fruits were put in the pots and assessed. Only fruits with fresh infestations or with live larvae were considered in the evaluation (exclusion of “old” stopped damage from first generation).
Statistical evaluation was done with contingency tables (Fishers Test, P = 99 %).

Results

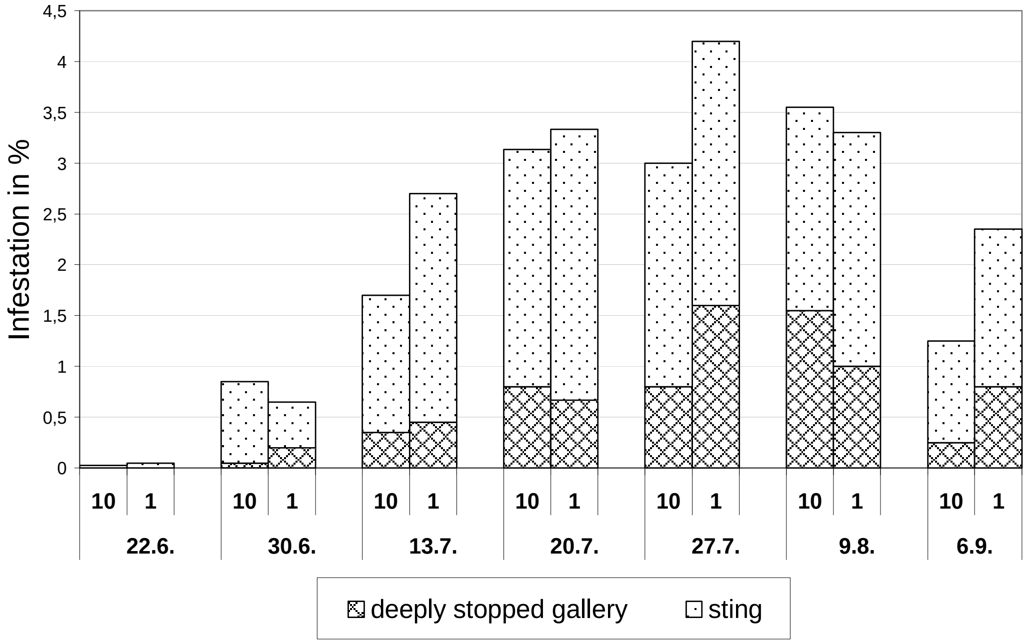
At the beginning of the season the infestation in both plots was nearly equal, even a little bit higher in the plot with 10 fold dosage. When dosage was increased in both plots the situation changed. At 13.7.05 a significant reduction of the living larvae in the high dosage plot could be observed (graph 1 and 2). The live larvae were even reduced significantly on 20.7.05.



Graph 1: CM Infestation at the different assessment times in the plots treated with one-fold (1) and 10 fold (10) dose of CpGV.



Infestation in %
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
10
1
22.6.
30.6.
13.7.
20.7.
27.7.
9.8.
6.9.
living larva



Infestation in %
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
10
1
22.6.
30.6.
13.7.
20.7.
27.7.
9.8.
6.9.
deeply stopped gallery
sting

Graph 2: Comparison between the effect of an increased dose of CpGV on the live larvae (upper figure), stings and stopped galleries (lower figure).

Further in the season there were still differences but they were not significant. The differences in infestation between the two plots were due to the reduction of the live larvae and not to an increase of the percentage of the "stopped" injuries (figure 2). There were few dead larvae found neither when fruits were cut immediately after the assessment neither when the fruits were left in laboratory until the larvae hatched.
The CM population in the orchard in the year 2005 was increasing in an impressive way which did not happened the years before. In an adjacent plot of the orchard which was not part of the trial but treated as usual, the same development of the CM population could be observed.

Discussion

Regarding the results, the question, why the CM population in this orchard did not rise like the population in Baden even if a low susceptibility of the CM population against CpGV was found in 2003, can be answered very simply: The exponential development of the population observed in other orchards started but now, in 2005. There was just a certain delay of time between the development of a population with low susceptibility against CpGV and real problems with CM infestation in the orchard. This delay does not seem to be due to the action of other natural antagonists. Additionally to the studies presented here, the diapausing larvae collected in 2003 and died during the overwintering were examined for the presence of entomopathogens and nematodes with very poor results so that considerable losses due to other natural antagonists during the overwintering period may be also excluded.
Even if the CM population is less susceptible to CpGV by a factor of 500 (Fritsch et al., 2004), the enhancement of the dose for the factor of 10 showed a certain effect in the field. It was observed that the increase of efficacy was mainly due to an effect on the "active" infestation (live larvae). Wether the "stopped" damage was only natural or there was an effect of the CpGV treatments on the stopped damage which, however, was not correlated with an increased dosage may not be discussed, because there was no untreated plot as comparison due to economic reasons. The results show, that the application of higher dosages of CpGV can be one instrument to prevent the increase of CM population even in orchards with problems with low susceptibility of CM against CpGV if used in time in combination with mating disruption.
However, the cost of treatments with 100 ml Madex/ha in intervals shorter than a week as practiced here is high and though the efficacy was not high enough for an efficient control of the population.
For organic farmers that start now having problems with CM it must be tested if *Bacillus thuringiensis,* which has a certain but not sufficient efficacy on CM, is not an economically interesting alternative to high dosages of CpGV. This would be interesting not only from economic point of view but also for a certain resistance management with different products. Under the impression of the latest development of the CM populations in organic orchards (Huber et al., 2006), it may be important to adopt such strategies in organic orchards.

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References

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