Regulation of *Cydia pomonella* in the Northern German climate

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Abstract

*Population control of the codling moth (*Cydia pomonella*) is of great importance in ecological fruit-growing. In the work described here we attempted (1) to determine the efficacy of plant protection preparations certified for organic fruit production, and (2) to develop a suitable application strategy. We found that a Granulovirus (Madex3),* Bacillus thuringiensis *(Xentari) and Neem Azal were able to provide effective control of* C. pomonella*. The reduced efficacy of Madex 3 as reported e.g. from some Southern German orchards could not be observed in our trials.*

Keywords: plant protection, apple, organic production, *Bacillus thuringiensis*, *Cydia*, Neem

Introduction

The codling moth (*Cydia pomonella* L.) is one of the most serious insect pests in all forms of apple production, and its control is of great importance in organic fruit-growing. Given suitable climatic conditions, an increase in population density can lead to explosive growth of subsequent generations. The population can be reduced to a tolerable level in the organic orchards only over a period of several years The introduction of Granulovirus Madex 3 has given organic farmers an effective means to regulate the population of *C. pomonella* in their orchards. However, a reduction in the efficacy of Madex 3 has been observed in recent years in Southern Germany, necessitating further research into alternative treatment strategies to control *C. pomonella* (Kienzle *et al*., 2006).

It was the intention of our trials to determine the effectiveness of Granulovirus (Madex3), *Bacillus thuringiensis* (Xentari) and Neem Azal against *C.pomonella* in organic orchards on the one hand, and to develop alternative treatment strategies on the other hand.

Material and methods

Large-scale field trials were performend in 2006 and 2007 in an organic orchard in Northern Germany. Trees were of the variety ‘Jonagored’, aged 10-11 years and had reached a height of 3 m. They were planted at intervals of 3.90 m x 1.30 m. The agents were sprayed with accustomed on-farm technology, using ID 90-015-C nozzles.

Developments of adult moth were monitored with pheromone traps. Treatments were made in accordance with the known degree-day (DD) models. The development of larvae was assumed to begin 88 DD after oviposition at a base temperature of 10 °C. We used the forecast model “RIMpro-Cydia” for determining the first and last applications of our trials.

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Trial 2006. – Every variant had an area of 365 m^2 and was composed of four parallel rows of 18-20 trees. Only the two middle rows were evaluated in order to avoid the influence of spray drift. Due to the uneven distribution of *C. pomonella* in the orchard, the trial was set up in duplicate, although only one replicate could be evaluated. Dates, dosage and costs of the applications are indicated in Table 1.

Fruit infestation with larvae of *C. pomonella* was evaluated on 28 July 2006, scoring 1000 fruits per variant. No difference was made at this stage between living larvae or aborted infections. During harvest, fruits of 10 trees per variant were collected. On the harvested fruits we distinguished between larvae aborted at or just below the fruit cuticle, larval infections stalled deeper within the fruit tissue, and infections of the apple core.

Table 1: Dates, dosage and costs of application for the codling moth trial in 2006.

	Dosage of application in l oder kg / ha / m crown height						
Variant	**18. June**	**23. June**	**28. June**	**4. July**	**10. July**	**15. July**	**€/ ha 2 m size**
Neem + Xentari	1.5 l + 0.5 kg	1.5 l + 0.5 kg	1.5 l + 0.5 kg	1.5 l + 0.5 kg	1.5 l + 0.5 kg	1.5 l + 0.5 kg	1035 €
Neem + Xentari	1.5 l+ 1.0 kg	0.3 l + 0.2 kg	0.3 l + 0.2 kg	0.3 l + 0.2 kg	0.3 l + 0.2 kg	0.3 l + 0.2 kg	345 €
Xentari	1.0 kg	1.0 kg	1.0 kg	1.0 kg	1.0 kg	1.0 kg	450 €
Madex	25 ml	10 ml	10 ml	10 ml	10 ml	10 ml	47 €
Madex	50 ml	50 ml	50 ml	50 ml	50 ml	50 ml	282 €

Trial 2007. – The trial took place on the same plot as 2006. Every variant had an area of 200 m^2 except for the control (320 m^2). The trial was replicated twice. Dates and dosage of application are shown in Table 2.

Fruit infestation with larvae of *C. pomonella* was evaluated on 31 July 2007, scoring 500 fruits per variant. Later, fruits of 14 trees per variant (22 trees for the control) were collected to enumerate postharvest fruit infestation by *C. pomonella*.

Table 2: Dates and dosage of applications for the codling moth trial in 2007. All sprays were carried out in 1000 l water / ha.

		Dosage of application in l oder kg / ha / m crown height
Nr.	**Variant**	From 1 June (first treatment) to 2 August (final treatment) treatments were carried out at intervals of 4-7 days depending on rainfall and solar irradiation.
1	**Madex 0.01% (split)**	first treatment 25 ml, subsequent treatments 5-10 ml
2	**Xentari 0,1% (full version)**	always 0.5 kg
3	**Combination of 1+ 2**	first treatment 25 ml, subsequent treatments 5-10 ml Madex 3; always 0,5 kg Xentari

Results

Trial 2006. – The analysis of the experiment showed different efficacies of the individual variants, as shown in Fig. 1. Against an infection of 5.3% in the untreated control, the efficacy of applied treatments ranged from 51% (0.6% Neem + 0.2% Xentari, split application) to 86% (0.3% Neem + 0.1% Xentari full treatment). 0.01% Madex in full application had a lower efficacy (61%) than when this was split into 6 applications (71%). The low efficacy of Madex 3 as observed by Kienzle *et al.* (2006) in Southern Germany could therefore not be confirmed in this trial in our area, even though MCpGV resistance was observed in an orchard nearby in a separate survey in 2007.

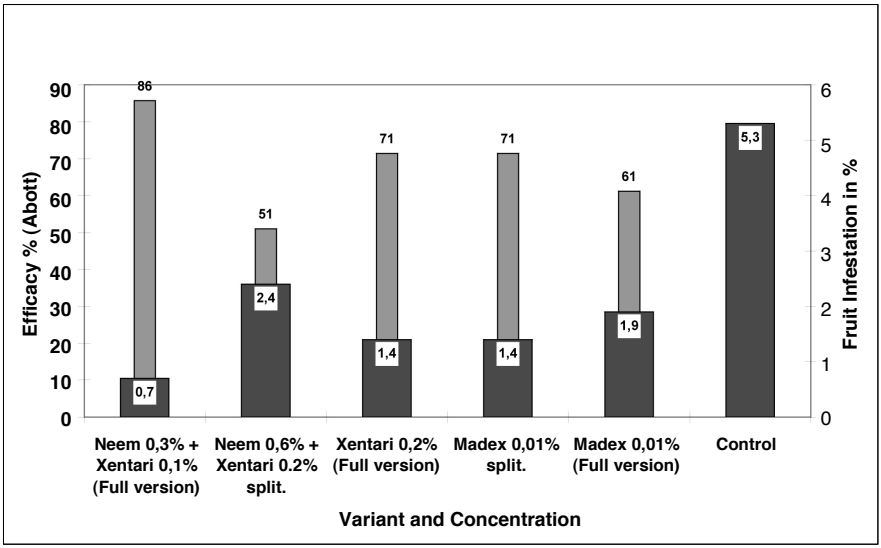

Figure 1: Fruit evaluation on 28 July 2006 (1000 fruits per variant), shown as efficacy of treatment (light bars) and percentage of infested fruits (dark bars).

Trial 2007. – The results of fruit evaluation are shown in Fig. 2. With the untreated control showing 4.3% infection, a narrow range of efficacies between 51% (Xentari 0.1% full, with or without 0.1% Madex split) and 58% (0.01% Madex split).

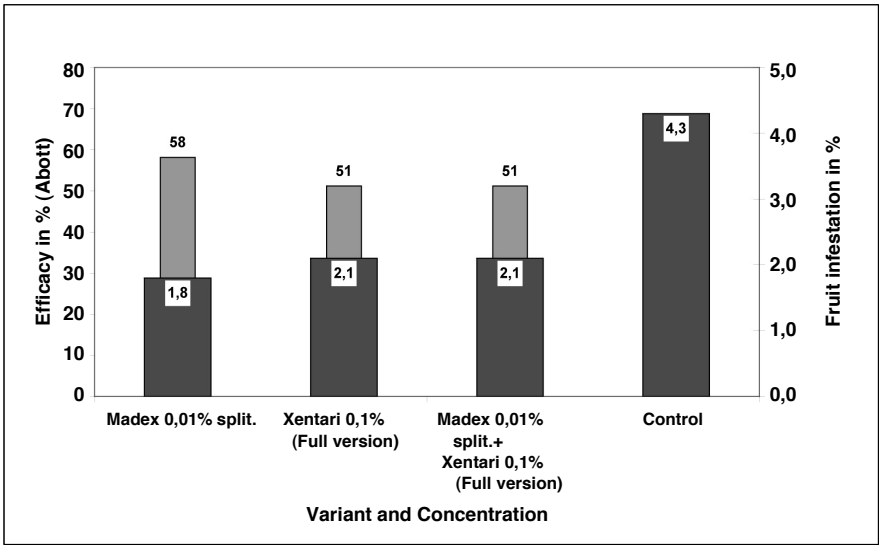

Fig. 2: Fruit evaluation on 31 July 2007 (500 fruits per variant), shown as efficacy of treatment (light bars) and percentage of infested fruits (dark bars).

Discussion

The trials described here provide some indication of the suitability of the tested agents Madex 3, Azadirachtin and *Bacillus thuringiensis* to control *C. pomonella* in Northern Germany. An application of of NeemAzal T/S repeated six times over the growing season would appear to be impossible in practice because of the expected negative effects on non-target fauna, and also because of high costs. The postharvest ratings confirmed the efficacy of Xentari (Efficacy 2006: 57%) which was similar to Madex3 (Benduhn *et al*., 2007). This agent is a licensed product in ecological fruit-growing to control freely feeding lepidoptera larvae. However, repeated and extended trials of the efficacy of *Bacillus thuringiensis* against *C. pomonella* will have to be conducted before this product can be recommended for practical uses.

References

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