Three years experience of apple sawfly control with entomopathogenic nematodes

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Abstract

The apple sawfly Hoplocampa testudinea *is one of the most important pests in organic fruit growing. In the years 2017-2019 the application of* Steinernema feltiae *onto the soil before sawfly emergence was tested in 15 field trials whether this could be a valuable tool to extend the toolbox to control this pest. A monitoring showed that forecasting the infestation pressure based on fruit damage of the previous year is not reliable. Besides these problems to decide on an application, the efficacy is very uncertain and could not be proved in most trials. The laborious application and the high cost of the application of entomopathogenic nematodes (EPN) has to be considered. Based on these results, EPN application currently cannot be recommended as a tool to reduce apple sawfly applications.*

Keywords: *Hoplocampa testudinea, Steinernema feltiae*

Introduction

The apple sawfly *Hoplocampa testudinea* Klug is one of the most important pests in organic fruit growing in several European countries, especially in Germany. Until now, there are few measures for the control of this pest available in the existing strategy. The continuous availability of the main control agent, an extract of *Quassia amara* L.*,* in the near future is currently still uncertain. For plum sawfly, promising results regarding an effect of entomopathogenic nematodes (EPN) on the adult sawfly hatching from the soil, were reported (Happe et al., 2016; Njezic, 2017). In the years 2017-2019 it was tested whether the application of EPN onto the soil before sawfly emergence could be a valuable tool to extend the toolbox for the control of the apple sawfly in organic fruit growing.

Material and Methods

The treatment aimed to reduce the number of adult sawflies. Since they are rather mobile in the orchard, the experimental design considered large plots. Usually, an orchard was divided into two parts: In one part the EPN were applied, the other part served as untreated control. Between the treated and the untreated plot a buffer zone of minimum 50 m was established. This buffer zone was treated with nematodes but was not included in the assessments. **Timing of the application** was determined by calculation of the first emerging sawfly following the method suggested by Trapman (2016). The first emergence and the peak of the flight of the sawflies were determined by white traps in the control and the nematode plot. The EPN *Steinernema feltiae* (Filipjev) was applied on the soil in all trials with an amount of EPN of 500,000 per m². In most trials the nematodes were applied only on the tree rows. In a few trials, the nematodes were applied on the tree rows and the alley (Table 1-2) since eclectors had shown that in some orchards sawflies emerged also from the alleys. The **application** was first performed with a special amendment of the sprayer that allowed the application on the soil of ca. 2,000 l per ha. Since the amount of water needed seemed much higher than feasible with such a construction, in several trials a liquid manure tanker was used for the application. The **period of efficacy of the EPN in the soil** in 2017 was

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assessed with soil samples that were evaluated by e-nema GmbH. In 2018 and 2019, a biotest was developed and applied in 7 tests to prove directly the activity of the nematodes in the soil: Small packs containing 5 mealworms and some sand were wrapped in gauze, buried in the soil and dug out after 1-3 days. The mealworms were kept humid for 1 week and then dissected to assess the presence of EPN larvae. The **infestation level** was assessed from 500 randomly selected blossom clusters for occurrence of sawfly eggs. For **monitoring the forecast reliability** of infestation pressure based on the level of fruit damage in the previous year, fruit clusters were assessed in several orchards for secondary damage in one year and for sawfly eggs in the following year.

Results and Discussion

The activity of the EPN in the soil monitored by bioassays in the tests 4, 5, 6, 7, 8, 13 and 14 proved to be high for about 3 weeks in 7 tests. Thus, in 2019 in some regions the application was scheduled some days before the forecasted emergence of the first sawfly since this was fixed exactly for the Easter holidays. However, the efficacy of the EPN applications was not reliable. Few differences were observed between control and treatment that could not be attributed to natural variation between plots (Table 1-2). However, when in the tests 5 and 6 in 2019, 20 adult sawflies were removed from the white traps and dissected, 4 of them proved to be infected by nematodes. Since sawflies are parthenogenetic insects, the oviposition usually starts one day after adult emergence. Thus, one of the reasons for failing success of these applications may be the fact that even infected sawflies succeeded still to oviposit before they were killed by the EPN.

Table 1: Results of the tests in Lake Constance area (LC) and in Saxony (S).

Test Nr./Year Region	Application and amount of water in l / ha	Application date/1st sawfly/peak of flight	Sawfly eggs in control plot (%)	Sawfly eggs in nematode plot (%)	Efficacy ABBOTT (%)
1/2017 S	Sprayer with 2,000 l water, after application second spray for wetting with 2,000 l, rain after	12.4./13.4./ 10.5.	Gala 4.4 Elstar 10.4 Jonagold 4.4	Gala 8.0 Elstar 8.6 Jonag. 7.8	-81,8 15,3 -72,7
2/2018 S	Sprayer with 3,000 l water, after application second spray for wetting with 3,000 l	22.4./21.4./ 24.4.	Remo 1.9 Rewena 1.6	Remo 8.2 Rewena 1.8	-331 -12.5
3/2018 S	Sprayer with 3,000 l water, after application second spray for wetting with 3,000 l	22.4./21.4./ 24.4.	Resi 2.2 Releika 2.9	Resi 0 Releika 4.8	100 -65.5
4/2018 LC	Sprayer with 4,000 l, wetting with 10,000 l with liquid manure tanker	21.4./21.4./ 28.4.	11.2	8.4	-33,3
5/2019 S	Sprayer with 6,000 l wetting before and after the application, 6,000 l application = 18,000 L. Appl. also in alley	15.4./23.4./ 1.5.	Remo 1.2	Remo 1.5	-25
6/2019 S	Sprayer with 6,000 l wetting before and after the application, 6000 l application = 18,000 L. Appl. also in alley	16.4./23.4./ 14.5.	Dalinco 0.8 Topaz 1.6	Dalinco 1.2 Topaz 1.7	-50 -6.3
7/2019 LC	Liquid manure tanker, treated alley and tree row with 25,000 l	12.4./22.4./ 25.4.	1.6	1.6	0
8/2019 LC	Application with liquid manure tanker with 10,000l/ha	12.4./22.4./ 25.4.	6.8	8.0	-17.6

Table 2: Results of the trials in Rhineland (R) and Lower Elbe (LE). * For R the data refer to damage controls not to the control of the eggs.

Trial Nr./Year Region	Application and amount of water in l per ha	Application date/1st sawfly/ peak of flight	Sawfly eggs in control plot in %	Sawfly eggs in nematode plot in %	Efficacy ABBOTT in %
9/2017 LE	Spray with 2,400 l during rainfall for several days	21.4./2.5./ 8.5.	18.0	39.0	-116.7
10/2018 LE	Spray with 2,400l/ha during rainfall (25 mm before, 25 mm after the application)	25.4./19.4./ 6.5.	11.5	10.5	8.7
11/2018 LE	Spray with 2,400l/ha during rainfall (25 mm before, 25 mm after the application)	25.4./2.5./ 6.5.	11.0	14.0	-27.3
12/2018 LE		25.4./30.4./ 8.5.	10.0	7.0	30.0
13/2018 R	Liquid manure tanker, application and wetting with 5,000 l each (= 10,000 l)	26.4./26.4./ 30.4.	Plot1: 3.25* Plot2: 2.71* Plot3: 5.88*	Plot1: 1.29* Plot2: 1.76* Plot3: 2.29*	60.3 34.9 61.0
14/2019 R	Liquid manure tanker, application and wetting with 5,000 l each (= 10,000 l)	26.4./26.4./ 6.5.	Plot1: 1.10 Plot2: 0.90 Plot3: 1.40	Plot1: 1.50 Plot2: 0.80 Plot3: 0.40	-36,36 11.11 71.42
15/2019 LE	Spray with 2,500l after application 12,500 l frost sprinkling	19.4./24.4./ 3.5.	Elstar 11.0 Jonagor.9.0	Elstar 12.0 Jonagor.11.0	-9.1 -22.2

However, also in tests where emergence and the main oviposition period were not quick succession the applications were not successful. Furthermore, the monitoring showed that the secondary infestation in the previous year was not a reliable criterion to forecast the infestation pressure. Although there are some orchards with a continuous high infestation level, more often the sawfly appeared unexpectedly and sudden in orchards with low infestation in the previous years. Sawflies are known to remain in the soil for several years before emergence, that means that adults of one year have not necessarily been developed from larvae of the previous year. Besides these difficulties to decide about an application, the very uncertain efficacy, the laborious application and also the cost of the EPN has to be considered. If only the tree row is treated, the number of nematodes is only a bit higher than for the application against codling moth larvae. If the whole orchard has to be treated, the amount is 5 x 10^9 EPN. In this case, the cost is more than triplicated. Based on these results, EPN application currently cannot be recommended as a tool for apple sawfly control.

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Citation of the full publication

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