Control of apple sawfly (*Hoplocampa testudinea* Klug) and plum sawflies (*H. flava* L. and *H. minuata* Christ.) with entomopathogenic nematodes

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Abstract

*Entomopathogenic nematodes (EPNs) were used for laboratory tests and open field treatments (OFT) to control apple and plum saw flies (*Hoplocampa *spp.). In lab test mortality of last instars was 92-100 % without differences between nematode species and applied number of dauer juvenile (DJ). Similarly, in the field EPNs have reduced infestion of fruits significantly compared to untreated control from 33-97 %. In another experiment the number of damaged fruits was also two to three times reduced after nematode application.*

Keywords: apple, EPN, *Hoplocampa* spp., plum, sawfly

Introduction

Sawflies are serious pests of plums, apples and pears in Europe. Damage in organic production and non-treated orchards can be in a range of 36-96 % (Caruso & Cera, 2004; Andreev & Kutinkova, 2010). Control strategy of sawflies in conventional farming is based on broad-spectrum insecticides. As an alternative, plant extract of *Quassia amara* can reduce numbers of fruit infested by apple sawfly (Neupane, 2012). The parasitoid wasp *Lathrolestes ensator* was extensively studied for its effect on apple sawflies, but parasitation was too low to avoid economic damage (Zijp & Blommers, 2002). No other biological measures are reported for commercial application in plum sawflies management. Considering high efficacy of entomopathogenic nematodes (EPN) against soil dwelling stages of several insect pests, the use of nematodes was evaluated against sawfly species in apples, pears and plums.

Material and Methods

Laboratory assays to test susceptibility of larvae of plum sawflies were done in 2012 and 2013 to assess the most susceptible stage of the target pests and the most effective nematode species. The essay was performed in Petri dishes of 5.5 cm diameter. 10 larvae were placed in each Petri dish filled with 10 g of sterile silver sand adjusted to 10% moisture by volume. Three species of EPN *Steinernema feltiae*, *S. carpocapsae* and *Heterorhabditis bacteriophora* were tested at densities of 50, 100, and 200 infective dauer juvenile (DJ) per larva.

Open field treatments (OFT) were set up in Banja Luka, Bosnia and Herzegowina, in 2013 and 2014 to control larvae of plum sawflies. The nematodes were applied before the anticipated day of first larval drop to the soil at the rate of 0.5 million nematodes/m^2 with 0.7 liters/m^2 and additional 1.5 liters of water after nematode application. Trees were covered by insect proof net.

In 2014 experiments were run at the experimental station Esteburg Jork, Germany against apple sawflies*. S. feltiae* was applied to the soil surface at a dosage of 0.5 million DJ per

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square meter (corresponding to 5 Bill. per ha). Trees were not covered by insect proof nets so insects could fly into the plots from outside of the trial area.

Results and Discussion

In laboratory tests age of larvae was considering. Mortality of last instars, which exited infested fruit, was 92 % - 100 % (Tab.1). When larvae were kept for longer than one day after exit of the fruit, they were unsusceptible. No significant differences were observed between treatments with different nematode species and number of DJ. When the cocoons containing older larva were opened mechanically and larvae were exposed to DJ, mortality was similar like recorded for larvae, which had just exited the fruit.

Table 1: Mortality of last instar plum sawfly larvae, which exited the infested fruit.

	Nematode species			
Number of DJ per larvae	*S. feltiae*	*S. carpocapsae*	*H.bacteriophora*	Control
50	92±8.37	96±6.99	95±7.07	12±7.89
100	98±4.22	99±3.16	98.89±3.3	12±7.89
200	100±0.0	100±0.0	100±0.0	12±7.89

In OFT, reduction in fruits infestation was 90-98 % (Table 2), whereas in 2014, 30-90 % (Table 3) was recorded. Lower efficacy in 2014 is explained by the late application when some sawflies had already emerged. Forecasting of adult emergence is essential for high control.

Table 2: Efficiency of 3 EPN species agains adult plum sawflies in 2013

	S. feltiae	*S. carpocapsae*	*H. bacteriophora*	Control
Number of infested fruits	12	25	47	469
Efficiency (%)	97.4	94.6	89.9	

Table 3. Efficiency of 3 EPN species agains adult plum sawflies in 2014

	S.feltiae	*S. carpocapsae*	*H. bacteriophora*	Control
Number of infested fruits	105	329	90	490
Efficiency (%)	78.6	32.9	81.6	

EPN are only effective against sawflies larvae before they make the coccon and again, when applied 7-14 days before adult sawflies emerge from the soil.

In 2014 experiments in Germany, the number of damage due to egg laying on fruit was reduced after application of *S. feltiae* and *H. bacteriophora* in two apple cultivars, Topaz and Jonagored, when compared to untreated plots (Table 4).

Table 4. Efficiency of *S. feltiae* against plum sawflies in 2014

	Cultivar Topaz		Cultivar Jonagored	
	S. feltiae	Untreated control	*S. feltiae*	Untreated control
Number of damaged fruit	46	118	55	134
Infestation (%)	0,76	1,96	1,1	2,68

Sawflies usually fly short distances should flowering trees be in the vicinity. However, if the trees have no flowers at the point of emergence they can fly larger distances to trees in blossom. Field results not using cages are thus influenced by immigrating sawflies. The soil moisture also influences success of the treatments. Soil must be moist enough to guarantee survival after application and establishment and activity during emergence of the adult saw flies. Another factor is the correct timing of the application. Apple saw flies emerge at 120 soil temperature degree-days (Rimantas Tamosiunas, personal communication) usually end of April (Graf *et al*., 1996). Nematode application should be done at 90 degree-days. The plum sawfly is much earlier. Whether the treatment against overwintering codling moth (*Cydia pomonella*) in spring can be combined with a control of sawflies needs to be investigated.

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