Combination strategy of biocontrol measures and antagonists for the control of leafrollers in organic apple orchards in Germany

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Abstract

Leafrollers, especially Adoxophyes orana *F.v.R. in the last years became important pests in more and more organic orchards in the South, East and North of Germany. Parasitisation rate and species composition in these three regions were recorded. A combination strategy of mating disruption with ISOMATE® CLR MAX and CAPEX® 2 is not harmful for these antagonists and gave successful control even in orchards with high infestation pressure.*

Keywords: Tortricidae, leafroller, parasitoids, *Teleutaea striata*, mating disruption

Introduction

In the last decade leafrollers were not considered important pests in most german orchards. In the last years, however, their population densities increased in the Lake Constance area, in Saxony and recently also in the Lower Elbe region in Northern Germany. It is well known that parasitoids are important antagonists of this pest. It has been also observed (Andermatt, 1989; Kienzle et al., 1995) that the use of the very specific granulovirus CAPEX® 2 to control *Adoxophyes orana* F.v.R. allows most parasitoids to hatch from larvae infected with this virus since they often die only in the last instar. Thus, CAPEX® 2 is recommended as an excellent tool to keep populations at a low level. If, however, population densities are very high, the application of CAPEX® 2 is not always sufficient to reduce the infestation to a level preventing damage. Therefore, it was tested, if in these cases a combination with mating disruption could achieve effective control. In all orchards, the parasitization rate was recorded to understand the role of parasitoids.

Material and Methods

In the years 2017, 2018 and 2019 in the Lake Constance area and Saxony as well as in 2019 in the Lower Elbe fruit growing region in Northern Germany near Hamburg, leafroller larvae were sampled in spring and in summer. The larvae were collected with a piece of apple leaves in the orchard and put individually into small plastic boxes. The larvae were fed with fresh untreated apple leaves until pupation, exitus or parasitoid emergence. The species of adult moths were determined. A portion of the parasitoids have already been determined on species level, a portion is still under determination.

To determine the infestation rate of the shoots, 1,000 randomly selected shoots per orchard were controlled for occurrence of leafroller larvae. Fruit damage was assessed on 1,000 randomly selected fruits per orchard.

A combination of application of CAPEX® 2 with half or full application rate and the mating disruption with ISOMATE® CLR MAX was tested. In the Lake Constance region, it was not possible to establish a control plot. In Saxony, plots with and without ISOMATE® CLR MAX

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were compared. Each plot had a minimum size of 1 ha and between the plots, a buffer zone of a minimum distance of 50 m was not assessed. CAPEX® 2 was applied in both plots.

Results and Discussion

In 2017, in one orchard in the Lake Constance area an infestation of about 15 % in spring and more than 50 % of the shoots in summer has been assessed. Parasitisation increased from about 10 % in spring to more than 30 % in summer. The fruit damage by the summer generation, which is usually less harmful to the apple since the larvae feed mainly on the shoots was 23 %. It was expected that the overwintering generation would damage more or less all apples in this orchard but the damage was only 14.7 %. In the next year, the infestation was about 4 % in spring and already about 30 % of the larvae were parasitised (Fig. 1). Due to the application of CAPEX® 2, a considerable part of the larvae died. However, most of parasitoids were able to emerge. In summer, the leafroller infestation was about 1 % of the shoots, with more than 50 % of the larvae parasitised. In combination with the effect of CAPEX® 2 and the mating disruption ISOMATE® CLR MAX a fruit damage of only 0.3 % (total of summer and autumn generation) could be achieved. The only parasitoid species assessed was *Teleutaea striata* Grav. Even samples in other orchards in 2017, 2018 and 2019 revealed only this species as antagonist in this region. Only once in 2018, 1 specimen of *Meteorus ictericus* Nees was found.

In Saxony, the parasitisation was very low and varied in 2017 from 0 % to 3.7 % in spring. However, species composition was more diverse: Besides *T. striata*, *Meteorus ictericus* and six other Braconidae not yet determined were found. In 2018, it varied from 0.9 to 13.2 % and the species composition was similar. In 2019, parasitisation rate varied between 1 and 3 %, however, eight different parasitoid species were observed.

In the Lower Elbe / Altes Land region, the parasitisation rate in 2019 was relatively high with 29 % in total. Species composition consisted of *M. ictericu*s and *T. striata* in equal parts, however strongly differing between the three sites. In the first site, 26.0 % of the larvae collected were parasitised by *T. striata* and only 13.3 % by *M. ictericus*. By contrast, *M. ictericus* dominated with 19.9 % over *T. striata* with 3.5 % in the second site. The third site generally had a lower parasitisation rate with 8.9 % for *M. ictericus* and 6.7 % for *T. striata*. With 38.1 %, the overall parasitisation rate was higher in spring than in summer with 27.5 %, although only *M. ictericus* could already be found this early.

Table 1: Summer infestation of *A. orana* on the shoots and fruit damage in autumn in the plots with and without mating disruption in 2019.

Trial Nr.	Variety	Infestation on the shoots in summer in %		Fruit damage in autumn in %	
		Control	Isomate CLR	Control	Isomate CLR
1	Dalinco	0	0	0	0
2	Roter Topaz	0	0.2	0	0
3	Dalinco	0	0.4	0	0
4	Roter Topaz	0.2	0	0	0
5	Galant	4.0	1.8	7.6	1.2
6	Galant	0.8	0.40	4.0	2.4
7	Santana	1.0	0	0.4	0
8	Santana	1.8	0	1.2	0.4
9	Red Jonaprince	1.8	0.6	0.8	0.4

In all regions, *Adoxophyes orana* was the main leafroller species, also responsible for the fruit damage. In 2019, in all regions the density of *Pandemis heparana* Den. & Schiff. increased considerably.

In Saxony, a clear effect of the mating disruption with ISOMATE® CLR MAX on the summer infestation and the fruit damage could be shown in cases when the infestation pressure was high and the efficacy of CAPEX® 2 alone gave no effective control (Table 1).

Conclusions

The combination of mating disruption and CAPEX® 2 gave successful control even at high infestation rates in Saxony and in the Lake Constance region. These results are also very promising since the population of *P. heparana* is increasing in all regions. This species is not controlled by CAPEX® 2 and – since the larva appear very dispersed from spring to summer - would be very difficult to control by *Bacillus thuringiensis* as frequent applications would be necessary. *P. heparana* is also controlled by ISOMATE® CLR MAX so that this strategy will be very attractive for German organic fruit growers in the next years. It has to be observed if leafroller species diversity will increase in the next years and the control strategy has to be adapted to more species.

Parasitoids proved to be important antagonists in the Lower Elbe region and in the Lake Constance area, contributing considerably to the control efficacy. Compared with samplings done in 1994 – 1996 in organic orchards at Lake Constance (Kienzle et al., 1997, 2015), the species diversity is now reduced very much resulting in *T. striata* nearly the only species observed. It has to be observed in the next years, if with the increasing population densities the species diversity of the parasitoids will increase. In the other regions, the species diversity of parasitoids was higher, but *T. striata,* an Ichneumoid species, which is known to be specialised on *A. orana* and to accept only *P. heparana* as alternative host, was always present.

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