Control of the apple sawfly (*Hoplocampa testudinea* Klug) with extracts from *Quassia amara* L.: Quality and combination with NeemAzal-T/S

Regulierung der Apfelsägewespe mit Auszügen aus *Quassia amara* und Kombination mit NeemAzal-T/S

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Abstract

In the last years the control of the apple sawfly *Hoplocampa testudinea* Klug was not efficient in organic fruit growing. This was due to quality problems of the "Quassia wood" used for the treatments. First orientating criteria based on one of the active ingredients, Quassin, were established for the quality of "Quassia" preparations. A field test on apple sawfly showed, that the quantity of Quassin per ha required for good sawfly control is about 12–18 g Quassin. In the next years, more active ingredients (i.e. Neoquassin) have to be included in the quality criteria and evaluated by biotests. Only this way, reliable recommendations can be given to the growers.

NeemAzal-T/S was effective only against the secondary infestation. Thus, it can be recommended only in situations with low infestation. The combination with Quassia (12 g Quassin/ha) did not give better results than Quassia alone. Antifeedant effects have to be considered and may provocate antagonistic effects.

Keywords

Sawfly, *Quassia amara,* Quassin, Neoquassin, Neem, apple

Introduction

Traditionally, in organic fruit growing an extract from Quassia wood is used for the control of the apple sawfly *Hoplocampa testudinea* Klug. The good efficacy of such preparations was shown in 1986 by BLOKSMA (1994), NOACK (personal communication, 1992 and 2001) and HOEHN et al. (1996). Nevertheless, there was always some uncertainty about the best application date and the duration of the effect of the treatment in years with a prolonged hatching period of the larvae. Thus, when in 1999 the efficacy of the treatments with Quassia wood was insufficient, at first this was attributed to difficulties in determination of the application date. However, when there was no efficacy of the treatments with most Quassia wood extracts also in 2000, it was realised that the problem was probably due to another reason. Thus, a discussion about the quality of the Quassia products started.

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The socalled "Quassia wood" is a traditional and well known botanical source of insecticide. Most authors dealing with the insecticidal properties of the plant (Servadei et al., 1972) denominate "Quassia wood" the wood originated either *from Quassia amara* L. (origin South America) or from *Picrasma excelsa* Sw., (origin Jamaica, Antilles) both members of the family of Simarubaceae. In the botanical classification the plant family Simarubaceae is called also the "Quassia wood" family. "Quassia wood" is denominated only *Quassia amara* whether *Picrasma excelsa* is called "bitter ash" (Kartesz, 1996).
Often, products are also sold as "bitter wood". Most available research results with "Quassia" were obtained preparing an extract from a definite quantity of "Quassia wood" of unknown quality or with the product "Quassan" produced by the company Bionomic in Switzerland. Not until the quality problem emerged it was realised that only vague informations were available about the nature and quantity of the active ingredients in an extract required for a good efficacy. In literature, only few data about the active ingredients of "Quassia" are found. As most important acitve ingredients Quassin (Nigakilacton D), Neoquassin and 18-Hydroxyquassin are cited (Dou et al., 1996; Hager 1977 in Wichtl 1997). The effects of these substances on insects can be different (Daido et al., 1993).
Since for the season of 2001 recommendations for the use of Quassia had to be provided for the fruitgrowers, the Foerdergemeinschaft Oekologischer Obstbau e.V. initiated first biotests on aphids to estimate roughly the insecticidal activity of the extracts. Besides, the company Trifolio-M GmbH developed a method of quantitative analysis of Quassin, one of the main active ingredients of "Quassia wood". In the meantime, this was extended to other Quassinoids. The Quassin analysis data were the presupposition for establishing first orientating criteria for the quality of any Quassia extract.
In literature, it is advised to use extracts from a quantity of 20-30 kg wood/ha (Servadei, 1972). Evans & Raj (1991) found a content of Quassin of 0.1-0.14 % in the dry substance of "Quassia wood". "Quassia wood" with a similar content of Quassin was macerated for 24 h and boiled for 1 h (100 g wood in 1,2 l water). In the solution prepared with 20 kg wood/ha, the Quassin content corresponded to an amount of Quassin of approx. 12 g/ha. Since the use of 20 – 30 kg of wood is usually recommended, it was presumed, that the quantity necessary for a good insecticidal activity of "Quassia wood" extract should be approx. 12 – 18 g Quassin for ha.
The "Quassia wood" originated from the plant *Quassia amara* found on sale showed a rather low content of Quassin (about 0,05 %). In this case, the quantity of wood used for the preparation of the extract had to be increased: 30 kg of wood per ha were assumed as sufficient for sawfly control.
This recommendation was given to the growers for 2001 (Kienzle & Schulz, 2001). With laboratory tests on aphids that took place at the University of Hohenheim it could be tested if an extract showed an insecticidal activity or not. However, the test could not give reliable results for the concentration necessary in the field for sawfly control.
Therefore, with the aim to give more consistent informations to the growers in 2002, the OekoBo, a group of fruit growers in the region of Lake Constance, con-

ducted an experiment with different concentrations of Quassia wood corresponding to 6,. 12 and 18 g/ha of Quassin. Since some activity of NeemAzal-T/S on sawfly had been reported before (ZIMMER, 2001), the possibility of combination of NeemAzal-T/S and Quassia should be tested. Furthermore, first observations about the duration of the effect of the treatments should be collected.

Material and Methods

The field trial in 2001 was laid out as a randomised block design with 3 replications per treatment in an organic orchard with the variety "Idared" near Lake Constance (Plot 1).
In a second plot with "Idared", situated 200 m apart, with a very high sawfly infestation, the trial was repeated with only one replication. Thus, the effect of the products at two different infestation intensities can be shown. In both plots, the trees were old and vigorous. Each replication included six trees.
The flight of the adults sawflies was monitored using white colour traps "Rebell". Infested fruits were controlled under the binocular to observe the development of the embryonic stage of the sawfly larvae in the eggs. According to these observations first application took place shortly before hatching of the larvae found in the first infested fruits. The second treatment was applied when the eggs deposited during the second peak of the flight reached this stage.

The following treatments were compared:

1 Untreated control
2 Quassia extract, 6 g Quassin/ha, first application date
3 Quassia extract, 12 g Quassin/ha, first application date
4 Quassia extract, 18 g Quassin/ha, first application date
5 Quassia extract, 12 g Quassin/ha, second application date
6 Quassia extract, 12 g Quassin/ha, first and second application date
7 NeemAzal-T/S 1 l/ha/m tree height
  + Quassia extract, 12 g Quassin/ha, first application date
8 NeemAzal-T/S 1 l/ha/m tree height, first application date

For the trials, a water extract from *Quassia amara* prepared by the company Trifolio-M GmbH with a defined content of Quassin was used.
The treatments were applied with a knapsack sprayer in the afternoon of May, 8, 2001 in replication 1-3 and in the morning of May, 9, 2001 in replication 4. The second application date was May, 14, 2001 in early afternoon. In the evening, 2 mm of precipitation was registered . Furthermore, during the following days 6 mm of rainfall was reported. Between the first and the second application no precipitation took place.
The primary infestation was assessed at May, 21, 2001. In each replication, 50 clusters were controlled for infested fruits. At May, 31, 2001, the secondary infestation was assessed.

Results

Figure 1 shows the flight activity of the adult sawflies in May. Two peaks could be observed: the first from May, 2 until 4, the second at May, 10, 2001. Thus, the interval between the peaks was about 6 to 8 days.
At the control of the sawfly eggs at May, 7, 2001, from 10 eggs controlled three eggs were rather fresh, the larvae in five eggs had nearly finished their development and from two eggs the larvae were hatching. At a control in May, 12, only fresh eggs or hatched larvae could be observed. One day later, most larvae were in an advanced embryonic stage, some even shortly before hatching.
Figure 1: Number of adults caught with the colour traps in the different plots

The efficacy of 12 and 18 g Quassin was nearly equal and high enough for sufficient control of the infestation (Table 1). The treatment with 6 g Quassin showed lower and varying efficacy.
The Quassia treatment only at the second application date was not very effective. Two Quassia treatments did not provoke a remarkable increase of the efficacy.

Table 1: Efficacy in % (ABBOTT) of the different treatments on primary and secondary infestation in replication 1-3 and replication 4 (Number of infested fruits per 50 clusters)

Treatments	Primary infestation		Secondary infestation	
Plot	Plot 2	Plot 1	Plot 2	Plot 1
Infestation in the control	**65**	**11.67**	**67**	**12.0**
Quassia extract, **6** g Quassin/ha first application date	75.4	31.4	73.1	82.1
Quassia extract, **12** g Quassin/ha first application date	81.5	74.3	88.1	92.3
Quassia extract, **18** g Quassin/ha first application date	80.0	82.9	97.0	92.3
Quassia extract, **12** g Quassin/ha, **only second application date**	52.3	28.6	77.6	87.2
Quassia extract, **12** g Quassin/ha **first and 2nd application date**	81.5	80.0	85.1	97.4
NeemAzal-T/S 1 l/ha/m tree height Quassia extract, **12** g Quassin/ha, first application date	89.2	77.1	83.6	84.6
NeemAzal-T/S 1 l/ha/m tree height first application date	33.8	-31.4	67.2	61.5

NeemAzal-T/S had no noticeable effect on primary infestation (Table 1). The effi-

cacy on secondary infestation, however, was more than 60 %. The combination of NeemAzal-T/S and Quassia did not give better results than the single treatment with Quassia alone.

Discussion

In this experiment, the efficacy of extracts containing 12 or 18 g Quassin was similar. Thus, it could be concluded that 12 g Quassin are sufficient for a good sawfly control. Other trials, however, which were performed in the frame of the EUGROF task force "sawfly" suggest a higher dose (about 18 g) necessary for higher efficacies (Zimmer, 2002; Fauriel, 2002). This may be due to different conditions during application or also to different application dates referring to the embryonic stage of the sawfly larvae. It has still to be discussed, if the activity of "Quassia" is best on eggs with mature larvae or on hatching larvae. Moreover, the effect on fresh eggs must be tested. The results of this trial suggests, that also with two distinct hatching periods one treatment might be sufficient, and, thus, a certain persistence of the activity of the extract and/or an activity on fresh eggs might exist. It must be considered, however, that between the two hatching periods there was no precipitation whether the second treatment was compromised probably by adverse weather conditions after the treatment. Furthermore, the second peak of the flight was much lower (Figure 1) and, therefore, the second hatching period was of lower relevance.

Thus, a definitive conclusion is not possible. Only observations on the effect on the different embryonic stages in combination with trials dealing with the duration of the activity of the extract in the field will allow conclusions for recommendations. Moreover, from unpublished experiments and experiences and from literture data, it seems possible, that the various active ingredients as i.e. Quassin and Neoquassin (DAIDO et al., 1993) show different activity on the embryonic stages.

If reproducible results are desired – and this is the first requirement for recommendations for the practice – trials have to be conducted with extract with known content of active ingredients. In 2001, it was shown that the content in Quassin can be a first orientating criterion to define quality of Quassia extracts. Nevertheless, it seems to be important to include at least Neoquassin in this criteria.

If quality criteria for "Quassia wood" are developed, also the plant of origin of the material has to be considered. In the EU-Regulation 2092/91, annex IIB, actually only "*Quassia amara*" is listed as a possible plant of origin for "Quassia".

Since the cost of two treatments with 18 g Quassin is very high and the apple sawfly is actually one of the most important pests in Germany, these questions must be resolved in the next years. The aim must be to establish for "Quassia" similar quality criteria based on the content of active ingredients as exist i.e. for Pyrethrum or Neem. With the varying quality of the raw material of "Quassia wood" or even "bitter wood" (which may include even material originated from other local species of Simarubaceae) actually on the market, this is the only way to provide reliable recommendations for the growers. For the cost calculation, however, it must be considered that it can generally be assumed and is sup-

ported by first tests of Trifolio-M that not all of the active ingredients from "Quassia wood" is extracted by the procedure mentioned before. Thus, with several extractions, the quantity of active ingredient obtained from a certain quantity of wood can be increased.
NeemAzal-T/S showed no effect on primary infestation whereas it gave appreciable results on secondary infestation. Considering the mode of action of Neem it was rather improbable that the eggs would be affected. If the mortality of the larvae is due to moulting disruption it will occur after the first larval instar. In this moment, the primary damage on the fruit has taken place.
For these reasons, even with higher concentrations of NeemAzal-T/S as i.e. 1,5 l/ha/m tree height a good efficacy on the primary infestation is not to be expected. This is confirmed by experiences in practice. The primary infestation, however, is only relevant if the infestation is high and most fruits are infested. With lower infestations, with NeemAzal-T/S a deficient control of the secondary damage can be achieved.
The combination of NeemAzal-T/S with Quassia even for secondary infestation did not improve the results. Since in the Quassia treatments in this trial a certain mortality of the later instar larvae was observed, the effects of both treatments might have been similar but not additive so that the results did not change in the combination. Since both products have antifeedant effects, antagonistic effects have to be considered, too. In the next years, it has to be tested if applications of NeemAzal-T/S some time after the Quassia treatment can increase mortality of the larvae that survived the Quassia treatment. Thus, the problem of a possible reduction of the Quassia uptake due to the antifeedant effect of Neem could be avoided. The Neem effect on fruit damage of such a treatment might be of low relevance but ir could be important for long term population management. However, it has to be considered that the sawfly larvae can remain in the soil for more than one winter. Thus, population control strategies must be discussed for an interval of at least four or five years.

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