Session 3: Plant protection control in eradication and containment regions

On the influence of different host plants and of insecticide treatments on the population development of the western corn rootworm *Diabrotica virgifera virgifera* LeConte (Coleoptera: Chrysomelidae)

Zum Einfluss verschiedener Wirtspflanzen und Insektizid Behandlungen auf die Populationsentwicklung des Westlichen Maiswurzelbohrers Diabrotica virgifera virgifera *LeConte (Coleoptera: Chrysomelidae)*

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Summary

D. virgifera virgifera is classified as a quarantine pest in Germany, therefore the trials, presented in this paper, were performed in the western part of Romania, where the pest is well established since more than ten years. The field tests were carried out in close collaboration with Banat's University of Agricultural Sciences and Veterinary Medicine, Timişoara.

On sites highly infested by *D. virgifera virgifera,* 1 m² plots in four replications per variable were planted with maize for the chemical treatments and alternative crops (cereals and weeds). Gauze covered hatch cages were used for weekly counts of the emerged adult *Diabrotica* during the hatch period from mid of June to mid of August.

It could be asserted that matured cereals are no host-plants for the western corn rootworm. In four years of trials not even one adult beetle hatched in the related cages.

Setaria viridis and *Digitaria sanguinalis* reduced the number of hatched imagines significantly, nevertheless some individuals survived. Therefore an effective herbicide management against grass weeds in maize is recommended to limit the chance of survival of the pest.

Clothianidin and Tefluthrin are effective against *D. virgifera virgifera*. 20% to 100% efficiency was assessed in the trials, strongly depending on precipitation and soil moisture in time of application. The insecticides decreased the maize root injury caused by larvae of the western corn rootworm significantly.

Keywords: Insecticides, crop rotation, host-plants, hatch cages

Zusammenfassung

Da der Westliche Maiswurzelbohrer in Deutschland noch als Quarantäneschädling eingestuft wird, wurden die Untersuchungen in Westrumänien durchgeführt, wo der Schädling bereits seit mehr als 10 Jahren etabliert ist. In Zusammenarbeit mit Banat's University of Agricultural Sciences and Veterinary Medicine, Timisoara, erfolgte die Anlage und Auswertung der Feldversuche.

Auf Versuchsflächen mit hohem *Diabrotica* Besatz wurden 1 m² große Parzellen (in vierfacher Wiederholung) mit Mais, für die Durchführung der Insektizidanwendungen, sowie mit alternativen Kulturen (Getreide und Ungräser) bestellt. Schlupfkäfige, die über die Parzellen gestellt wurden, dienten der wöchentlichen Zählung der aus dem Boden schlüpfenden Käfer während der Schlupfperiode, von Mitte Juni bis Mitte August.

Es konnte festgestellt werden, dass die weit entwickelten Getreidearten keine Wirtpflanze für den Westlichen Maiswurzelbohrer darstellten. In den vierjährigen Versuchen konnte kein Käfer in den entsprechenden Käfigen gefunden werden.

Setaria viridis and *Digitaria sanguinalis* reduzierten die Anzahl der gefangenen adulten *D. virgifera virgifera* signifikant, einige Exemplare überlebten jedoch auch. Eine wirksame Ungras Bekämpfung im Mais und den nachfolgenden Kulturen wird deshalb empfohlen um die Überlebensmöglichkeiten für *D. virgifera virgifera* zu begrenzen.

Clothianidin und Tefluthrin reduzierten die Anzahl der schlüpfenden Imagines. Wirkungsgrade von 20% bis 100% konnten ermittelt werden, weitgehend unabhängig von der Formulierung. Dabei war die Wirksamkeit

der Insektizide sehr stark abhängig von der Bodenfeuchte bei und kurz nach der Anwendung. Die eingesetzten Präparate verminderten die Schäden an den Maiswurzeln signifikant.

Stichwörter: Insektizide, Fruchtfolge, Wirtspflanzen, Schlupfkäfige

1. Introduction

The western corn rootworm is one of the most destructive pests in maize. Since 2007 *D. virgifera virgifera* is present in Germany. In order to improve and adapt control measures, including chemical and non chemical options for German conditions a research program was generated in 2008, funded by the German Federal Ministry of Food, Agriculture and Consumer Protection and the Bavarian State Ministry of Food, Agriculture and Forestry. This study is part of this program.

As the population density of the western corn rootworm in Germany was not high enough to achieve reliable results, trials were performed in countries where the pest was already well-established. It was supposed that the findings could be applied to Bavarian conditions in this case.

The influence of insecticidal treatments on the population development of *D. virgifera virgifera* was often tested in different countries in previous years. A summary of elder investigations in the USA is given by van Rozen and Ester (2007). Results from seed dressing experiments to control *Diabrotica* larvae were obtained from trials in Hungary e.g. (Tóth and Hatala Zsellér, 2007) and Italy (Breitenbach *et al.*, 2007).

The aim of the study presented here was to confirm the well-known results from other countries and to test the insecticides already commercially available in Germany at that time, or those which were expected to be registered soon by quantifying the impact of potential host-plants and chemical treatments on the *Diabrotica* populations.

Crop rotation is a common measure to contain the western corn rootworm population in quantity and spreading (Bertossa *et al.*, 2009). Many studies were carried out to get information about other host-plants than corn. In laboratory tests it was shown that *Diabrotica* larvae even developed on barley, wheat and rice (Branson and Ortman, 1967, 1970). On the other hand it was indicated that the insect did not develop on wheat under field conditions (Breitenbach *et al.* 2005, 2006 and 2008).

The main goal of the trials performed from 2009 till 2012 in Romania was to confirm the results on the host-plant suitability of wheat and barley. Additionally two grass weeds (*Setaria viridis* and *Digitaria sanguinalis*) were also included in the tests.

2. Material and methods

On a field naturally infested with *D. virgifera virgifera,* small plots of 1 m^2 ground surface, were planted with maize (for the chemical treatments) and with cereals or weeds (for the host-plant suitability test).

Hatch cages as described in Tab. 1, were set up on the plots (see also Fig.1 and Fig. 2). A yellow sticky trap was placed inside the cages.

Tab. 1 Description of the hatch cages used in the test.

Tab. 1 *Beschreibung der verwendeten Schlupfkäfige .*

Soil-surface area	1.00 m^2 (1.00 m x 1.00 m)
Height	1.40 m
Timber frame	1.06 m x 1.06 m (outside), 0.15 m height; (thereof 0.13 m below soil-surface). Since 2010 the timber frame was replaced by a ferrule (0.05 m high)
Clothing	Gauze, mesh width 0.2 mm
Timber pile	0.08 m diameter, 1.80 m high (thereof 0.40 m below surface), in the center
Opening	1.0 m length, closed by hook-and-pile fastener

Weekly counts of hatched adults in the cages were carried out throughout the hatching period between mid of June and mid of August.

Fig. 1 Maize plot with hatch cage.
Abb. 1 *Maisschlag mit Schlupfkäfig.*

Fig. 2 Trial design (hatch cages with quadratic width).
Abb. 2 *Versuchsdesign (Schlupfkäfige mit quadratischem Grundriss).*

The assessment of the maize-root damage caused by *D. virgifera virgifera* larvae was performed by the end of August or beginning of September. To describe the intensity of destruction the Root-Node-Injury Scale was applied (Oleson *et al.,* 2005), 0=no injury, 3=roots totally damaged.

The trial plan is shown in Tab. 2

Tab. 2 Trial plan.

Tab. 2 *Versuchsplan.*

Entry	Crop	Product	Active Ingredient	Formulation	Year			
					2009	2010	2011	2012
1	Maize	untreated			X	X	X	X
2	Maize	Poncho Pro	Clothianidin 62.5 g/unit	seed dressing	X	X	X	X
3	Maize	Force 1.5 G	Tefluthrin 180.0 g/ha	granulate	X	X	X	X
4	Maize	Santana	Clothianidin 84.0 g/ha	granulate	-	X	X	X
5	Winter wheat				X[1)]	-	X	X
6	Spring barley				X	X	X	X
7	*Setaria viridis*				-	X	X	X
8	*Digitaria sanguinalis*				-	X	X	X

1)=spring wheat, -)=variant not applied

3. Results

The number of adult *D. virgifera virgifera* fluctuated significantly from year to year (Fig. 3). Due to strong precipitation in spring 2010 (end of May > beginning of June) the test site was partly flooded during several days. The *Diabrotica* population decreased significantly. As no sufficient number of beetles could be expected for the next season, the trial was moved to another field, where the western corn rootworm could build up an adequate population even in 2010.

In the cereal plots no adult *Diabrotica* was found. *S. viridis* and *D. sanguinalis* reduced the number of hatched imagines significantly, nevertheless some individuals survived (Fig. 3).

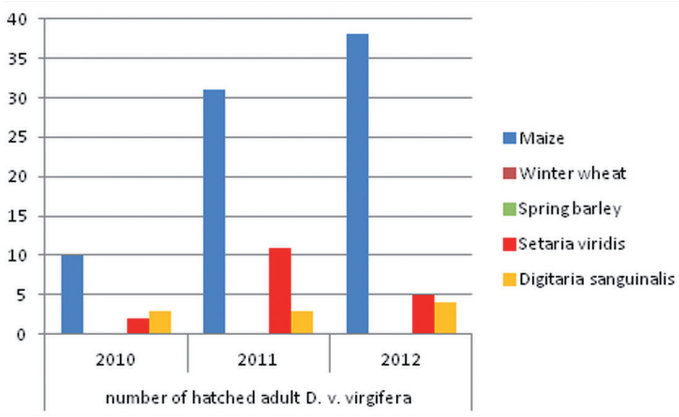

Fig. 3 Number of hatched adult *D. virgifera virgifera* per entry throughout the whole hatch period.

Abb. 3 *Anzahl gefangener adulter* D. virgifera virgifera *je Variante während des gesamten Fangzeitraums.*

The efficiency of the insecticides included in the test varied between 20–100%. In the trials presented, the seed dressing was slightly more effective than the granulate formulations (Fig. 4).

Dry periods after sowing reduced the insecticidal efficacy significantly, more or less independent of the formulation. The insecticide treatments reduced the damage to maize roots (Fig. 5).

A linear correlation between the number of emerged adult *Diabrotica* and maize root damage could not be confirmed (r^2=0,036); possibly, the sample size was too small to perform a proper analysis.

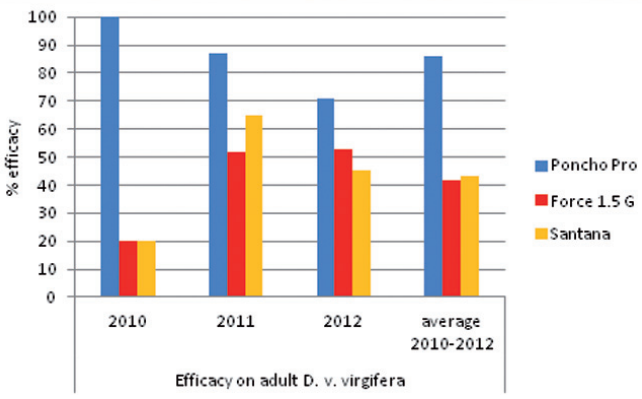

Fig. 4 Efficacy of insecticide treatments to adult *D. virgifera virgifera* with regard to the number of imagines in the hatch cages.

Abb. 4 *Die Wirkung von Insektitizidbehandlungen gegen adulte* D. virgifera virgifera *anhand der Anzahl der Imagines in den Fangkäfigen.*

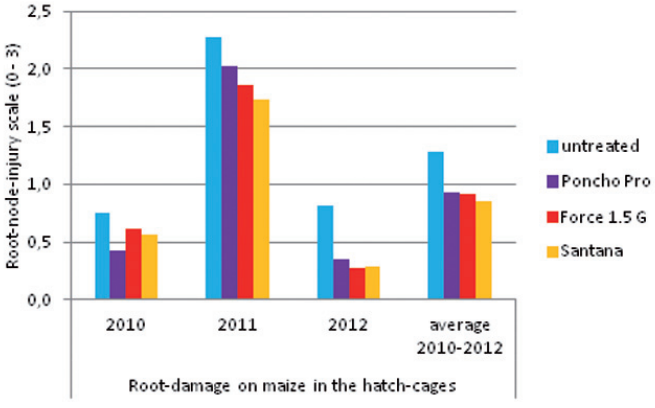

Fig. 5 Impact of insecticide treatments on maize root damage in the hatch cages.

Abb. 5 *Der Einfluss von Insektizidbehandlungen auf Maiswurzelschäden in den Fangkäfigen.*

4. Discussion

The number of adult *D. virgifera virgifera* fluctuated significantly from year to year. Due to strong precipitation in spring 2010 (end of May > beginning of June) the test site was partly flooded during several days. A survey performed in Kansas (Riedell and Sutter, 1995) showed, that water saturated soils during egg hatch can adversely impact western corn rootworm populations and subsequent larval feeding damage. It is well known, that the egg hatch period in Romania is in accordance with the time when the high precipitation happened.

On the other hand a study performed in Austria (Grabenweger *et al.*, 2010) shows, that the physical soil characteristics like permeability for water and air affect the mobility of *D. virgifera virgifera* larvae. Reduced mobility increases the possibility of drying up. That's what took place in the years 2011 and 2012, when it was extremely dry between June and September.

In the cereal plots no adult *Diabrotica* was found.

It has to be considered, that in Romania spring barley and winter wheat are already widely matured mid of June (harvest time is end of June/beginning of July). Therefore they may no longer be suit-

able to feed the western corn rootworm. This could be different in case of volunteer cereals. Several studies show that the insect did not develop on wheat under field conditions (Breitenbach *et al.,* 2005, 2006 and 2008). Cereals are an important part in the crop rotation to contain the *D. virgifera virgifera* population (Breitenbach *et al.*, 2006). This is also widely confirmed by practical experiences in countries with high *Diabrotica* infestation.

S. viridis and *D. sanguinalis* reduced the number of hatched imagines significantly, nevertheless some individuals survived. Therefore an effective herbicide management against grass weeds in maize is recommended to limit the chance of survival of the pest. These findings are confirmed by former studies performed in the same area in Romania (Breitenbach et. al, 2005, 2008).

The efficiency of the insecticides included in the test varied between 20 – 100%. In the trials presented, the seed dressing was slightly more effective than the granulate formulations.

Dry periods after sowing reduced the insecticidal efficacy significantly, more or less independent of the formulation. The insecticides decreased the maize root injury caused by larvae of the western corn rootworm significantly.

These findings are confirm with studies from Italy (Breitenbach et. al, 2007), which showed an efficacy of Clothianidin seed dressing of about 50% against hatched adult *D. virgifera virgifera*. The active ingredient was used in two concentrations but they showed similar results. Maize-root damages could obviously be reduced. The author stated that, regarding a low to moderate infestation with western corn rootworm seed dressing could be a suitable method within an IPM-strategy to control or to reduce the population.

In fields highly infested with *D. virgifera virgifera* in Yugoslavia (Tóth and Hatala Zseller, 2007) and Hungary (Ripka *et al.*, 2007) insecticidal seed treatments with Clothianidin were not able to reduce the damage caused by western corn rootworm larvae under the economic threshold (<3 of Iowa scale value).

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