
Session 4: Agronomic measures for eradication and containment

On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm *Diabrotica virgifera virgifera* LeConte (Col.: Chrysomelidae)

Untersuchungen zum Einfluss unterschiedlicher Bodenbearbeitungsverfahren im Herbst und im Frühjahr auf die Populationsdynamik des Westlichen Maiswurzelbohrers (Diabrotica virgifera virgifera LeConte)

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Summary

It can be expected that intensity and depth of soil cultivation have an impact on the eggs of *Diabrotica virgifera virgifera*, which are predominantly positioned 10 to 15 cm below soil surface. Main aim of this study was to investigate the relationship between different cultivation measures in autumn and spring and the hatching of adult *D. virgifera virgifera* as well as the maize root damage, caused by larvae. Gauze covered hatch-cages (2 per plot) were used to count the emerged imagines. Variants: Plough and grub, both 25 cm working depth, in autumn and superficial tillage with disc-harrow in spring. The trials were performed on fields with a significant natural *D. virgifera virgifera* infestation, in West Romania. The number of hatched adult *D. virgifera virgifera* was unsteady in

the different years and did not correlate with soil-cultivation practices. This finding can be explained with the different climatic conditions in the single years. The maize-root damage under the hatch-cages was not significantly different between variants. This may on the one hand result from the limited number of samples (2 cages per plot) on the other hand also from the artificial growth circumstances for the maize under the small cages. The maize-root damage assessed in the surrounding plots was significantly lower in the plough-variant compared to those in the grubber- and disc-harrow-plots, in two of three years. A summary of all data achieved in three years, showed a significant correlation between the number of adult *D. virgifera virgifera* and the maize-root damages in the field ($p=0.0001$, $r=0.605$).

Keywords: *Diabrotica*, cultivation measures; plough; cultivator; disc-harrow; integrated control

Zusammenfassung

Es ist zu erwarten, dass Art und Tiefe der Bodenbearbeitung einen Einfluss auf die Eier von *Diabrotica virgifera virgifera* haben, die bevorzugt in einer Tiefe von 10 bis 20 cm abgelegt werden. Ziel des Projektes war es, den Zusammenhang zwischen verschiedenen Bodenbearbeitungsverfahren im Herbst und im Frühjahr und der Anzahl schlüpfender Imagines des Westlichen Maiswurzelbohrers sowie der durch die Larven verursachten Wurzelschäden am Mais, zu untersuchen. Die Versuche wurden auf Feldern mit starkem Besatz mit *D. virgifera virgifera*, in West Rumänien, durchgeführt. Versuchsvarianten waren: Pflügen und Grubbern im Herbst (jeweils 25 cm Arbeitstiefe) und oberflächliche Bodenbearbeitung mit einer Scheibenegge im Frühjahr (10 - 15 cm Arbeitstiefe). Die Anzahl geschlüpfter Käfer war in den drei Versuchsjahren sehr unterschiedlich. Grund dafür könnten die sehr unterschiedlichen Witterungsbedingungen in den einzelnen Jahren gewesen sein. Die Wurzelschäden an den Maispflanzen unter den Schlupfkäfigen unterschieden sich zwischen den Bodenbearbeitungsvarianten nicht signifikant. Das kann an der relativ geringen Probenzahl (2 Schlupfkäfige pro Parzelle) liegen, wird jedoch auch von den Wachstumsbedingungen der Maispflanze unter den relativ kleinen Gazekäfigen beeinflusst worden sein. Wurzelschäden am Mais in der umgebenden Parzelle, verursacht durch Larvenfraß, waren in der gepflügten

Variante in zwei von drei Jahren signifikant geringer als in den Vergleichsvarianten. Die Zusammenfassung aller erhobenen Daten in den drei Versuchsjahren, zeigte eine signifikante lineare Korrelation zwischen der Anzahl geschlüpfter Käfer und den Schäden an den Maiswurzeln ($p = 0,0001$; $r = 0,605$).

Stichwörter: *Diabrotica*, Bodenbearbeitung; Pflug; Grubber; Scheibenegge; integrierte Bekämpfung

1. Introduction

Since 2007 *Diabrotica virgifera virgifera* is present in Germany. As this species is classified as a quarantine pest official required measures, following EU-Decision 2003/766/EU and EU-recommendation 2006/565/EU, have to be applied to avoid further spreading and to eradicate the population (HALM, 2007).

In order to improve and adapt control measures for *D. virgifera virgifera*, including chemical and non chemical options for German conditions two research programs were generated, funded by the German Federal Ministry of Food, Agriculture and Consumer Protection and the Bavarian State Ministry of Food, Agriculture and Forestry (ZELLNER *et al.*, 2009). The work presented in the following is part of this research program.

The influence of soil preparation on the population dynamics of *D. virgifera virgifera* is not well reviewed in Europe. However it could be expected that intensity and depth of soil preparation would have an impact on *Diabrotica* eggs, which are predominantly positioned 10 to 15 cm below soil surface (SCHWABE *et al.*, 2010)

Main aim of this study was to investigate the relationship between different soil preparation measures in autumn and spring and the hatching of *D. virgifera virgifera* imagines and the intensity of maize-root damage, caused by larvae feeding.

The trials had to be performed on fields with a significant natural *D. virgifera virgifera* infestation where maize was grown in single-crop farming. An appropriate site was found at the boundary between Grabaș and Lenauheim, two villages in the Banat region 45 km west of the city of Timișoara, Romania. It was a large and long field. Due to technical reasons it was decided to put both trials on this site, each at one end. The distance between the trials was about 100 m.

Soil cultivation was managed in collaboration with the owner of the field by using his farming equipment.

2. Material and methods

The project started in autumn 2009 and was completed in autumn 2012

Three cultivation measures were applied:

- plough, 25 cm working depth, in autumn (Fig. 1),
- grubber, 25 cm working depth, in autumn (Fig. 2),
- superficial cultivation by disc-harrow (10 to 15 cm working depth), in spring.

The maize was planted with a standard seed combination across all plots.

Large plots (500 m², 4 replications) were appropriate to work with the farmer's equipment (Fig. 3). They were also necessary to avoid adult *D. virgifera virgifera* moving across plots.

Gauze covered hatch cages (2 per plot) were used to count the emerging adult *D. virgifera virgifera*. A single plot is shown in Fig. 4; the whole set of cages in a trial can be seen in Fig. 5.

Imagines were counted weekly throughout the hatching period from mid of June till mid of August. Each year in September or October the maize root damage caused by *Diabrotica* larvae were assessed inside the hatch cages and in the surrounding plot, by using the 'Root-Node-Injury Scale' from 0 to 3 (OLESON *et al.*, 2005).

All plants (5 to 6) under the hatch-cages were assessed, whereas 5 x 5 succeeding plants in the surrounding plot were evaluated.



Fig. 1 Cultivation using a plough.

Abb. 1 Bodenbearbeitung mit einem Pflug.



Fig. 2 Cultivation using a grubber.

Abb. 2 Bodenbearbeitung mit einem Grubber.



Fig. 3 Trial site after soil cultivation in autumn, Lenaheim 2011.

Abb. 3 Versuchsflaeche nach der Bodenbearbeitung im Herbst, Lenaheim 2011.



Fig. 4 Hatch cage, 1.4 m height, ground surface 1 m², with gauze clothing.

Abb. 4 Fangkäfig, 1,4 m hoch, Bodenfläche 1 m², Abdeckung mit Gaze.



Fig. 5 Hatch cages (2 per plot), Lenauheim, 2012.

Abb. 5 Fangkäfige (2 je Schlag), Lenauheim, 2012.

3. Results

During the test period it became apparent, that the trial results were unsteady from year to year. It was obvious that the differences between the variants were not mono causal. As soil cultivation, sowing date and assessments were performed nearly at the same time it was decided to put the data achieved from both trials together and to regard them as one experiment with 8 replications in the statistical analysis.

- The number of hatched adult *D. virgifera virgifera* was unsteady in the different years and did not correlate with the soil cultivation practices (Fig. 6).
- The maize root damage under the hatch cages were not significantly different between variants (Fig. 7).
- The maize root damages assessed in the plots surrounding the hatch-cages were significantly lower in the plough variant compared to those in the grubber and disc harrow plots, in two of three years (Fig. 8).
- A summary of all data achieved in three years, showed a significant correlation between the number of adult *D. virgifera virgifera* and the maize root damage in the field ($p=0.0001$, $r=0.605$).

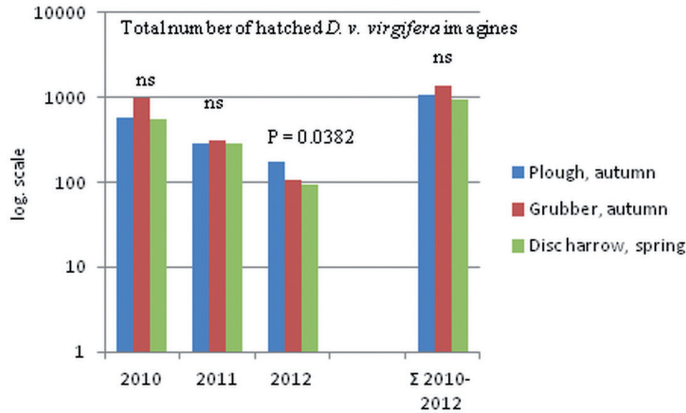


Fig. 6 Total number of adult *D. virgifera virgifera* caught in the single variants and years and mean values.
Abb. 6 Gesamtanzahl gefangener adulter *D. virgifera virgifera* je Variante und Jahr und Durchschnittswerte.

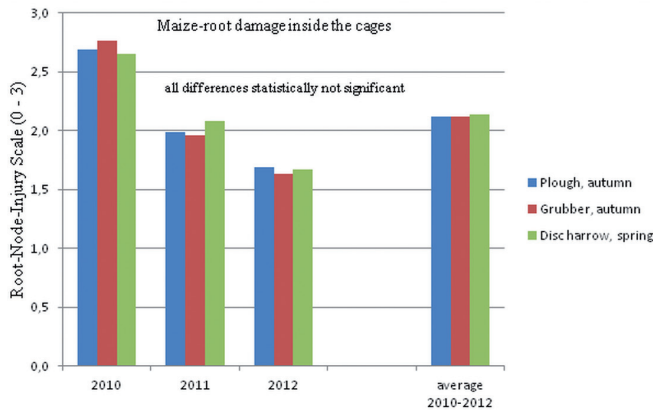


Fig. 7 Maize root damage inside the hatch cages, in the single variants and years and mean values.
Abb. 7 Maiswurzelschaden innerhalb der Schlupfkäfige je Variante und Jahr und Durchschnittswerte.

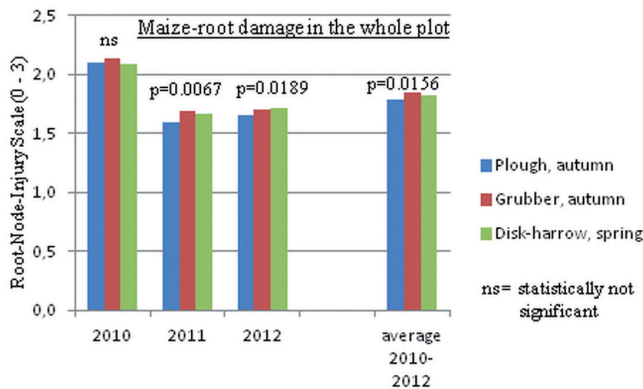


Fig. 8 Maize root damage assessed in the whole plot, single variants and years and mean values.
Abb. 8 Schaden an Maiswurzeln im ganzen Schlag je Variante und Jahr und Durchschnittswerte.

4. Discussion

A study on the influence of soil conditions on the survival rate of *D. virgifera virgifera* larvae in Austria (GRABENWEGER *et al.*, 2010) shows, that the physical soil characteristics like permeability for water and air affect the mobility of *Diabrotica* larvae. Reduced mobility increases the possibility of drying up.

On the other hand a survey performed in Kansas (RIEDEL AND SUTTER, 1995) showed, that water saturated soils during egg hatch can adversely affect western corn rootworm populations and subsequent larval feeding damage.

No ovipositional preference for a tillage system was evident in a study performed in Iowa from 1983 till 1985 (GRAY AND TOLLEFSON, 1988), but egg population declined significantly from fall 1983 to spring 1984 in the plough variants whereas no significant reduction in egg population occurred in the non tillage and superficial treatments. No differences were found in the next vegetation period.

All studies confirmed, that many abiotic components have an impact on the population-dynamics of the western corn rootworm.

The results mentioned above are reflecting the situation in West Romania during the trials period (2010–2012). The first year (2010) was hallmarked by heavy rainfalls end of May and beginning of June; the trial site was partly flooded during a few days. As the *Diabrotica* egg hatching occurs in that period the population decreased significantly. In 2011 and 2012 it was very dry between June and September. This also had a negative impact on *Diabrotica* population development.

These climatic influences can explain that the number of hatched adult *D. virgifera virgifera* in the trials was unsteady in the different years and did not correlate with the soil tillage practices.

The finding that the maize-root damage under the hatch cages were not significantly different between variants may on the one hand result from the limited number of samples (2 cages per plot) on the other hand also from the artificial growth circumstances for the maize plants under the small cages.

The maize root damage assessed in the surrounding plots were significantly lower in the plough variant compared to those in the grubber and disc harrow plots, in two of three years.

In laboratory tests eggs of the western corn rootworm were placed in different soil depth; the related egg hatching rate was assessed. A negative correlation between the soil depth (40 cm) and the egg hatching rate could be observed. In a comparable field trial carried out in the USA, the laboratory finding could be confirmed in the first of two years but not in the second one (BAUFELD, 2012). As these studies were performed in the laboratory and under field conditions in the USA, the results are not directly comparable with those achieved from the Romanian trials but they are confirming the tendency.

To confirm a significant correlation between the number of adult *D. virgifera virgifera* and the maize-root damages in the field seems to be natural. The various influences affecting the *Diabrotica* population development as mentioned above indicate that even this is not a matter of course.

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