

Research into the population-dynamics, the host-plant specificity and the influence of insecticide treatments and soil preparation on the population-development of the Western Corn Rootworm *Diabrotica virgifera virgifera* LeConte (Col.: Chrysomelidae)

- A project presentation -

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Abstract The Western Corn Rootworm *Diabrotica virgifera virgifera* LeConte (*D. virgifera*) is classified as a quarantine pest in Germany. Officially required measures have to be applied, to avoid further spread and to eradicate the population. As shown in other countries it is nearly impractical to stop the invasion of *D. virgifera* completely. So locally adapted control measures have to be developed.

In an international scientific investigation, funded by the Federal State of Bavaria and coordinated by the Plant Protection Institute of the Bavarian State Research Center for Agriculture, strategies for an integrated control of *D. virgifera*, adapted to the local Bavarian situation, are to be developed.

In cooperation with Banat's University of Agricultural Sciences and Veterinary Medicine, Timisoara, basic research on population dynamics, host-plant specificity and the influence of different agricultural measures on the development of *D. virgifera* populations is carried out in semi-field and field tests.

Main target of the investigations is to generate information on the economic threshold of the pest and on the influence of crop rotation and different insecticidal control measures, on the population development.

Material and methods used in the study, first results and the further progressing of the work are described and discussed in the paper.

Key words

Diabrotica virgifera virgifera LeConte; population development; crop rotation; soil preparation; integrated control

The invasion of Europe by the Western Corn Rootworm (*D. virgifera*), one of the most destructive corn pests, is ongoing and represents a serious threat to the European agriculture (Miller et al., 2005). After its accidental introduction in Serbia prior to 1993 it's now actively spreading throughout Southeast Europe and from there into Central Europe (Wudtke et. al., 2005). First in 2007 *D. virgifera* was detected in the Upper Rhine Valley in Southwest Germany and in Bavaria in Southern Germany. As this species is classified as a quarantine pest officially required measures, following EU-Decision 2003/766/EU and EU-recommendation 2006/565/EU, have to be applied to avoid further spread and to eradicate the population (Halm, 2007). As it seems to be unlikely that the invasion of *D. virgifera* can be stopped completely, locally adapted control measures have to be developed to be prepared to advise farmers accordingly.

The absence of a sufficient number of beetles to get reliable trial-results in Germany, requires cooperation with countries where the corn is highly infested.

An international scientific investigation, funded by the Federal State of Bavaria and coordinated by the Plant Protection Institute of the Bavarian State Research Center for Agriculture, was implemented to develop integrated control strategies against *D. virgifera*, adapted to the local Bavarian situation. Scientists from Germany, Austria, Hungary and Romania are participating in the project.

In cooperation with Banat's University of Agricultural Sciences and Veterinary Medicine, Timisoara, basic research on population dynamics, economic thresholds, host-plant specificity and the influence of different agricultural measures (e.g. crop rotation and soil preparation) on the development of *D. virgifera* populations is carried out in semi-field and field tests in Banat.

Material and Methods

The project is structured as follows:

1. Investigation on the population-dynamics of *D. virgifera* in maize-monoculture, starting from different numbers of beetles per plant.
2. Evaluation of the development of *D. virgifera* on different crops with the target to delimit the migration of the pest by applying an appropriate crop rotation and the influence of chemical pest control by seed treatment, granulate-application or spray-treatment on the population development.
3. Investigation on the influence of different soil preparation measures in autumn and spring on the population dynamics of *D. virgifera*.

As all component projects require a different methodology, they will be presented separately:

1. Investigation on the population-dynamics of *D. virgifera* in maize-monoculture, starting from different numbers of beetles per plant.

As it seems to be unlikely that the invasion of *D. virgifera* in Germany can be stopped completely, locally adapted control measures have to be developed. To find a reliable control strategy, detailed knowledge on the biology of the pest, e.g. population dynamics and the impact on the yield is required.

It was essential to install this semi field test on a site not naturally infested by *D. virgifera*. Such a field could be found at the Experimental Station Lovrin, owned by the Romanian Academy of Agricultural Sciences. Since more than 10 years from now no maize was grown there.

This test was performed by using gauze-covered cages to ensure a controlled population development without any influence by the natural *D. virgifera* population (see figures 1-3 and table 1).



Fig. 1: Prearrangement of frames in the field



Fig 2: Installation of cages in the field



Fig. 3: Cages planted with maize

Table 1**Technical data of the gauze-covered cages**

Surface area	2,00 m ² (1.41 m x 1.41 m)
Height	2,40 m
Oak-timber frame	1.46 m x 1.46 m (outside), 0.15 m height; (thereof 0.13 m below surface)
Corners and top	Thin angle steel
Clothing	Gauze, mesh width 0,2 mm.
Square timber	0.08 m x 0,08 m, 2.40 m high (in the center, fixed with an appropriate metal sleeve)
Port	1.5 m length, closed by a hook-and-pile fastener

The cages were planted with maize, density 80.000 plants/ha (16 plants/cage) by using an appropriate caliber.

It was necessary to irrigate from time to time.

In the third July decade, adult *D. virgifera* were caught in naturally infested maize fields and put into the cages.

The trial includes 4 variables, in 6 replications:

- Var. 1: control plot without *D. virgifera*
- Var. 2 start population 1 adult *D. virgifera* per plant (16 per cage)
- Var. 3 start population 3 adult *D. virgifera* per plant (48 per cage)
- Var. 4 start population 5 adult *D. virgifera* per plant (80 per cage)

864 *D. virgifera* (50% females, 50 % males) in total

Test procedure:

- 1st year: establishing of the start population
- 2nd year: assessment of infestation and plant damage, in 1 cage per variable
yield measurement in all plots
- 3rd year: assessment of infestation, plant damage and yield in all cages.

Plant injury assessment according to the Node-Injury Scale (Oleson et.al., 2005)

Yield assessment by single plant harvest.

This test was initiated in 2009 and will be finished in 2011. It will be replicated and starts again in parallel to the ongoing experiment in 2010 and ends up in 2012.

2. Evaluation of the development of *D. virgifera* on different crops with the target to delimit the migration of the pest by applying an appropriate

crop rotation and the influence of chemical pest control by seed treatment, granulate-application or spray-treatment on the population development.

In this investigation, the same type of cages as already described were used and placed adjacent to the trial mentioned before.

The trial includes 7 variables, in 4 replications:

- Var. 1: maize spray treatment with Thiachlopid (Biscaya)
- Var. 2 maize seed coating with Thiachlopid (Poncho Pro)
- Var. 3 maize granular application of Tefluthrin (Force 1.5 G)
- Var. 4 winter wheat
- Var. 5 maize (followed by winter wheat in the 3rd year)
- Var. 6 sorghum
- Var. 7 maize delayed sowing, end of May, to simulate a catch crop situation.

Test procedure:

- 1st year: maize sowing in all cages
establishing of the start population of 5 adult *D. virgifera* per plant
- 2nd year: cultivation of rotational crops
chemical pest control
monitoring of hatching larvae
- 3rd year: maize sowing (winter wheat in plot 5)
assessment of *D. virgifera* infestation and crop injury in all cages.

In a second part of the study, smaller cages (ground surface 1 m²) where installed on a field, highly naturally infested with *D. virgifera*, to investigate the influence of rotational crops and chemical pest control on larvae hatching.

This methodology is easy to apply and offers annual results although the exact amount of larvae in the soil is not detected.

A suitable field was also found at the Experimental Station Lovrin on a site, where corn was grown in monoculture since 14 years.



Fig. 4: Plant sowing April 2009

The cages concerned and the sowing of the different crops are shown in figure 4 to 6; technical data in table 2.



Fig. 5: Small cages to avoid adult *D. virgifera* from outside to get into the plots

Table 2

Technical data of the gauze-covered small cages

Surface area	1,00 m ² (1.00 m x 1.00 m)
Height	1,60 m
Timber frame	1.06 m x 1.06 m (outside), 0.15 m height; (thereof 0.13 m below surface). From 2010 the timber frame will be replaced by a ferrule
Clothing	Gauze, mesh width 0,2 mm
Timber pile	0.08 m diameter, 2.00 m high (thereof 0.35 m below surface), in the center
Port	1.0 m length, closed by a hook-and-pile fastener

The trial includes 7 variables, in 4 replications:

- Var. 1 maize, untreated
- Var. 2 maize seed coating with Thiachloprid (Poncho Pro)
- Var. 3 maize granular application of Tefluthrin (Force 1.5 G)
- Var. 4 spring barley
- Var. 5 spring wheat (since 2010: maize granular application of Thiachloprid (Santana))
- Var. 6 *Setaria viridis* (L.) P. Beauv.
- Var. 7 *Digitaria sanguinalis* (L.) Scop.

Test procedure:

The experiment has to be reinstalled every year at another part of the field, applying the following workflow:

- ploughing in autumn
- soil preparation in spring (partly manually)
- sowing of barley, *S. viridis* and *D. sanguinalis*
- sowing of maize and application of the insecticidal granules.
- installation of the cages
- hand weeding (if necessary)
- monitoring of hatching larvae (from mid of June till end of the hatching phase in August)
- removing of the cages

This test was at first applied in 2009 and will be

continued till 2012. So results out of 4 years will be available.

3. Investigation on the influence of different soil preparation measures in autumn and spring on the population dynamics of *D. virgifera*.

The influence of soil preparation on the population dynamics of *D. virgifera* is not well reviewed in Europe. However it can be expected that the intensity and depth of soil preparation has an impact on the eggs of the insect, which are predominantly positioned 10 to 15 cm below soil surface.

Main target of this study is to investigate the relationship between different soil preparation measures in autumn and spring and the hatching of *D. virgifera* larvae.

The trials had to be provided on sites with a significant natural *D. virgifera* infestation.

The ongoing study is performed at two sites in Grabatz and Lenaheim. The soil preparation was managed in cooperation with the owner of the fields by using his equipment.

The study includes 3 variables, in 4 replications:

Var. 1: plough, 0.25 m working depth, in autumn (Figures 6 and 7)

Var. 2: grubber with crumble roller, 0.25 m working depth, in autumn (Figures 8 and 9)

Var. 3: grubber with crumble roller, 0.25 m working depth, in spring

All plots will be planted with maize, using a sowing combination of rotary cultivator and sowing machine.



Fig. 6: Ploughing, working depth 0.25 m



Fig. 7: Plough, used in the trials



Fig. 8: Grubber, working depth 0.25 m



Fig. 9: Soil preparation with grubber

Test procedure:

1st year: assessment of root damage due to *D. virgifera* infestation, prior to soil preparation (figures 10 and 11)

soil preparation with plough and grubber in autumn
2nd year: soil preparation in Var. 3, in spring
maize planting

monitoring of hatching larvae, using two 1 m² cages per plot (see table 2).
 assessment of root damage, using the 'node injury scale', as already described (see figures 20 and 11)
 soil preparation with plough and grubber
 3rd year: soil preparation in Var. 3, in spring maize planting
 monitoring of hatching larvae



Fig. 10: Root injury assessment

assessment of root damage
 soil preparation with plough and grubber in autumn
 4th year: soil preparation in Var. 3, in spring maize planting
 monitoring of hatching larvae
 assessment of root damage

The ongoing trials started in 2009 and will be terminated end of 2012.



Fig. 11: Root damaged by *D. virgifera*

Results

All experiments concerned were initiated in 2009 and 2010 respectively. That implicates, that first results cannot be expected before end of 2010.

Preliminary information can be drawn out of the trials in the small tents. The first results from 2009 indicate, that no *D. virgifera* larvae hatched in the plots sown with cereals (spring barley and spring wheat), whereas in the untreated control plot and in the plots treated with insecticides a significant hatching of *D. virgifera* larvae was detected.

This confirms not yet published results of K. F. Lauer, from trials, carried out from 2006 to 2008 in a comparable trial design (personal information).

Beside this notice the results show that the test model used is working sufficiently.

Conclusions

The invasion of *D. virgifera*, one of the most destructive pests in corn, in Southeast Europe and the active spreading into Central Europe, requires a close cooperation between the countries concerned to develop integrated control strategies.

The studies described are part of an international scientific investigation, funded by the Federal State of Bavaria, Germany, and coordinated by the Plant Protection Institute of the Bavarian State Research Center for Agriculture.

The trials are performed in cooperation with scientists of BANATS's UNIVERSITY of AGRICULTURE and VETERINARY MEDICINE, TIMISOARA.

All intended tests are installed or will be set up in due time. First findings show, that the test system is working and useful results can be expected during the coming years.

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