

Western corn rootworm: Experiments on the improvement of monitoring at low population densities

Westlicher Maiswurzelbohrer: Untersuchungen zur Verbesserung des Monitorings bei geringen Populationsdichten

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Summary

An efficient monitoring of the western corn rootworm (WCR) *Diabrotica virgifera virgifera* LeConte, 1868 (Chrysomelidae, Coleoptera) is the most important precondition for convenient measures of eradication or containment. This research project aimed to assess the monitoring methods, especially at low population densities as currently observed in Germany. For this purpose, large-scaled field trials were designed in Bavaria and Upper Austria. The studies focused on the catchability, costs and by-catches of the pheromone-trap PAL in comparison to other trap types. In another experiment, different allocations of PAL traps in the corn field were examined. Finally, traps and pheromones often remain unused at the end of a monitoring season. Therefore the catchability of stored PAL traps in the next monitoring period was investigated.

PAL traps captured beetles constantly on a high level. In addition to its low costs and reduced by-catches, the trap type PAL is recommended for the monitoring of western corn rootworm in Germany. Changes in locations of PAL traps within the corn field did not result in a higher catchability. At present, traps are placed in the fifth to eighth corn row and the results confirm to maintain this practice. Comparing the catchability of stored PAL traps to the catchability of fresh traps, stored traps resulted in comparable catches than fresh ones. It is concluded that traps and pheromones, which were stored dark and deep-frozen, can be used in the next season.

Keywords: *Diabrotica virgifera virgifera*, monitoring, PAL-trap, pheromone traps

Zusammenfassung

Ein effektives Monitoring des Maisschädlings Westlicher Maiswurzelbohrer (*Diabrotica virgifera virgifera* LeConte 1868, Chrysomelidae, Coleoptera) ist die wichtigste Voraussetzung für zielgerichtete Ausrottungs- bzw. Eingrenzungsmaßnahmen. Im vorliegenden Forschungsprojekt wurde das bestehende Monitoring speziell unter geringen Befallsdichten, wie sie derzeit in Deutschland vorherrschen, überprüft. Dazu wurden großräumige Freilandversuche in Bayern und Oberösterreich angelegt. Untersuchungsschwerpunkt war die Überprüfung der Fängigkeit, Kosten und Beifänge des aktuell verwendeten Pheromon-Fallentyps PAL im Vergleich zu anderen Fallentypen. Ein weiterer Versuchsteil untersuchte verschiedene Anordnungen der PAL-Fallen im Maisfeld. Am Ende einer Monitoringsaison bleiben oft ungebrauchte Fallen und Pheromone übrig. Deshalb wurde die Fängigkeit von eingelagerten PAL-Fallen in der nächsten Monitoringperiode untersucht.

Der Fallentyp PAL erwies sich als durchgehend sehr fängig. In Verbindung mit seinem verhältnismäßig günstigen Preis und seinen reduzierten Beifangraten kann er für das Monitoring des Westlichen Maiswurzelbohrers in Deutschland empfohlen werden. Eine veränderte Position der PAL-Fallen im Feld ergab keine verbesserte Fängigkeit. Die aktuell praktizierte Anbringung der Fallen in der fünften bis achten Maisreihe sollte beibehalten werden. Bei den eingelagerten PAL-Fallen konnte keine nachlassende Fängigkeit nachgewiesen werden. Dunkel gelagert bzw. mit tiefgekühlt aufbewahrt Pheromon sind die Fallen ohne Fängigkeitsminderung in der nächsten Saison einsetzbar.

Stichwörter: *Diabrotica virgifera virgifera*, Monitoring, PAL, Pheromonfalle

1. Introduction

The western corn rootworm *Diabrotica virgifera virgifera* is the most dangerous pest infesting corn fields. This harmful leaf beetle was introduced from North America to Europe during the Balkan wars and was first detected in 1992 near to the airport of Belgrade (Bača, 1993). In North America the beetle causes every year lots of plant protection expenses and received for this the nickname "Billion dollar bug". From Belgrade the WCR population extended the following years like ripples in a pond to the surrounding countries. In 2007 the first *Diabrotica* individuals in Germany could be

found in Baden-Wuerttemberg and in Bavaria (BOEGEL, 2007).

The trap type PAL was one of the first traps which was specifically produced for the WCR. It works on the base of female sex pheromone and attracts mainly male individuals (TÓTH *et al.*, 1996). Several other traps were designed in the following years, partly not using the sex pheromones but other attractants (TÓTH *et al.*, 2006).

In Bavaria there is the special situation that *Diabrotica* populations show low to very low abundances all over the federal state. Therefore the catchability of the different trap types mentioned above was investigated under these specific conditions in Bavaria within the German Diabrotica Research Program.



Fig. 1 Examination of a yellow panel trap for *Diabrotica virgifera virgifera*.

Abb. 1 Untersuchung einer Gelbtafel auf *Diabrotica virgifera virgifera*.

2. Material and Methods

The trap type PAL, produced and delivered by Csalomon in Hungary, is currently used in most of the European countries and therefore part of the official monitoring on western corn rootworm in Bavaria. Four main issues with some subquestions should be answered in the course of this Bavarian project:

- 1) Do other trap types catch significantly better than the trap type PAL? Which trap of them could be recommended for a monitoring in the case of low population densities of WCR?
- 2) Ordinary yellow panel traps are much cheaper than the PAL trap. Is it possible to run an efficient monitoring by using yellow traps instead of PAL?
- 3) Up to now the PAL traps are placed within the fifth to eighth row in a corn field. Would it be better to change the position of the PAL-traps within the corn field to different rows? Should they be placed more into the center of the field or vice versa more to an outer row?
- 4) In case that not all PAL traps were used during a season is there any loss of quality by storing them? Is it possible to use them still in the next year?

For answering these questions large field-scale trials were designed both in the district Passau in Lower Bavaria and in the district Perg in Upper Austria. Locations were selected where corn was grown following corn.

To assess whether the PAL trap could be replaced by another trap type, in 2009 to 2011 ten different trap types were examined in comparison to PAL (Table 1). In 2009 the tests were performed in Lower Bavaria and Upper Austria, in 2010 only in Lower Bavaria and in 2011 again in both regions.

Tab. 1 Tested traps and their characteristics.

Tab. 1 *Untersuchte Fallenarten und ihre Charakteristika.*

Name of Trap	Bait	Coloured (sheet)	Funnel or hat	Killing the catch by	Photo
PAL	pheromone	transparent	---	glue	
PALx	pheromone	yellow	---	glue	
PALs	kairomone (floral)	yellow	---	glue	
KLPfero+	pheromone	yellow	hat	insecticide	
KLPflor+	kairomone (floral)	yellow	hat	insecticide	
Unitrap	pheromone	green/transparent	funnel	insecticide	
Deltatrap	pheromone	green	---	glue	
Deltax	pheromone	transparent	---	glue	
Pherocon AM	---	yellow	---	glue	
Multigard Green	---	yellow	---	glue	
Multigard Yellow	---	yellow	---	glue	

The traps were placed into the fields at a distance of at least 30 metres between each trap (effects between traps could therefore be almost avoided). After 14 days the traps were substituted and in addition the position of a trap within the corn field was changed like in a circle. For estimating the catchability of the different trap types the result of the PAL trap was defined as the reference (100 percent).

Ordinary yellow panel traps like Pherocon AM are with 0,98 € much cheaper than PAL traps with 6,10 €. For the regular Bavarian monitoring which needs about 3,500 PAL traps per year the replacement of PAL traps by the cheaper yellow panel trap would result in an economic benefit (savings of almost 18,000 € per year) if the efficiency would be comparable. Therefore in 2010 in Lower Bavaria (with a very low *Diabrotica* infestation level) 717 PAL traps and 717 Pherocon AM traps were compared to each other with respect to their efficacy. In Upper Austria (with a moderate *Diabrotica* level) 360 PAL traps and 360 Pherocon AM traps were included in the assessment.

At present PAL traps are fixed onto the plants in a height of about 1.50 meters in the fifth to eighth row of a corn field. If monitoring results could be enhanced by only changing the position of the trap to another row the improvement could be achieved without any additional costs. In 2010 and 2011 altogether in 95 test fields in Lower Bavaria and Upper Austria the PAL traps were fixed in the first, the 7th and the 14th row with a space of 30 metres in between. Every seven days the traps were substituted and according to this substitution each position of a trap was changed within the rows. Finally the loss of quality of PAL traps was of interest in case that not all of them were used within one season. Is it possible to use the gluey panels and the pheromones in the following season if they are stored in a cool and dark place? For this test the panels were stored at a temperature lower than +5 °C and the pheromones were frozen to a temperature of -18 °C. PAL traps of the season 2010 were stored and used for testing in 2011 in each of the 25 corn fields in Lower Bavaria and Upper Austria. The stored PAL traps of 2010 as well as new PAL traps bought in 2011 and exposed shortly to the same temperature conditions were checked for their catchability.

3. Results

In comparison to the PAL trap only the PALx trap, which is a combination of a PAL trap with a yellow sheet, showed satisfying results in all cases. In Lower Bavaria as well as in Upper Austria the PALx was 2011 the most catchable trap, in 2010 it was almost as successful as the PAL trap. But the difference between PAL and PALx was not significant. Only one of the hat traps, KLPfero+ proved to be significantly the best trap in 2009 in Upper Austria. The traps containing the floral bait as well as the two traps in delta form and the funnel trap showed almost no catchability at lower population densities of *Diabrotica virgifera virgifera*. The three different yellow sheets with no bait did absolutely not attract WCR but instead many other arthropods which respond primarily to the colour yellow.

The comparative test between PAL trap and an example of a yellow panel trap (Pherocon AM) led to a highly significant result. Table 2 shows the numbers of *Diabrotica* catches in the traps.

Tab. 2 Comparison of PAL trap with yellow panel trap Pherocon AM.

Tab. 2 Vergleich von PAL-Fallen mit Pherocon AM Gelbtafeln.

	Total number of traps tested	Traps with WCR	WCR catches (number of beetles)
Lower Bavaria			
PAL	717	12	22
Pherocon AM	717	0	0
Upper Austria			
PAL	360	168	1,739
Pherocon AM	360	6	7

The number of positive traps with WCR catches – irrelevant of how many individuals were caught – was significantly higher for the PAL trap. That conclusion can be drawn for both regions - for Lower Bavaria, a region with a very low *Diabrotica* population density level, and as well for Upper Austria, a region with a moderate infestation level. In addition the total number of WCR catches, especially in Upper Austria, underpins the result that the PAL trap is much more attractive than an ordinary yellow panel.

Within the experiments with respect to changing of rows where traps should be placed numbers of WCR catches in Bavaria were too small to perform a statistical analysis. Table 3 therefore only shows the Austrian results. Only complete data sets were considered – in case that one trap had to be excluded the whole data set was deleted.

Tab. 3 Effect of PAL trap position within the corn field – results of Upper Austria.

Tab. 3 Einfluss der PAL-Fallenposition im Maisfeld – Ergebnisse aus Oberösterreich.

Year	Row	Data sets	Traps with WCR	Percentage of traps	WCR catches	Percentage of catches
2010	1	234	60	25.6	504	29.5
	7	234	63	26.9	592	34.7
	14	234	75	32.1	612	35.8
2011	1	119	69	58.0	1,783	31.1
	7	119	80	67.2	2,076	36.2
	14	119	81	68.1	1,883	32.7

The differences in the numbers of positive traps with WCR as well as the difference in the total numbers of WCR catches were statistically not significant.

Results for the comparison of stored PAL traps to fresh traps are shown in Table 4.

Tab. 4 Catchability of stored PAL traps in comparison to fresh PAL traps.

Tab. 4 Fängigkeit von gelagerten und frischen (ungelagerten) PAL-Fallen.

Region	Condition	Data sets	Traps with WCR	Percentage of traps	WCR catches	Percentage of catches
Bavaria	stored	372	17	4.6	22	52.4
	fresh	372	10	2.7	20	47.6
Upper Austria	stored	351	268	76.4	8,701	59.8
	fresh	351	223	63.5	5,853	40.2

The difference in the catchability was statistically not significant, but especially in Austria the stored PAL traps appeared to have a slightly better catchability.

4. Conclusions

According to the above described results the two trap types PAL and PALx are the only traps which could be recommended for a WCR monitoring at low population densities. Since the other types of traps did only catch some few individuals of *Diabrotica virgifera virgifera* if the population had already reached a certain extent, they cannot be recommended for a WCR monitoring in a non-infested area or at the outer range of a *Diabrotica* region due to the risk of too low catchability.

Yellow panel traps without bait are not suitable for an effective WCR monitoring. The catchability was negligible low in comparison to PAL traps. In summary, yellow panel traps cannot replace the PAL trap type – despite the low price.

The results showed that for a monitoring the PAL traps could be placed in corn rows 1, 7 or 14 without significant differences in the catchability. For an efficient monitoring it is even more important to hide the traps within the field in order that nobody would remove them. The first row should for this reason not be used. In addition traps may not be found if they are placed too deep within the corn field thus giving as well a disadvantage to the 14th row. Therefore the current standard of placing the traps within the fifth to eighth row should be maintained.

Stored PAL traps did not prove to have a decreased quality in catchability compared to fresh PAL traps – in the test 2011 they even seemed to work better. The producer confirmed that the composition of the pheromone element is the same for years. Only the composition of the glue changed in small details from 2010 to 2011. Maybe this other glue had a little influence on the catchability, but nevertheless it was statistical of no significance. The recommendation is now that stored PAL traps and frozen pheromones from the previous year can be used without problems in the subsequent year.

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