

REVIEW OF TRAPS USED TO CAPTURE ADULTS OF DIABROTICA VIRGIFERA IN CORN CROPS

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Abstract. *Diabrotica virgifera* is one of the threats to maize crops worldwide. The damage caused by this pest is significant, impacting both the yield and quality of maize crops, causing substantial economic losses to farmers. Monitoring *Diabrotica virgifera* populations is essential in the management and control of this beetle. An effective and also non-invasive method of monitoring populations is the use of traps. More and more approaches in the specialized literature bring attention to the use of traps as an alternative to the use of pesticides, because biopesticides are considered expensive and inapplicable to all pests. This method is easy and can be applied by any farmer without the necessary qualification. That's why we set out to analyze the types of traps available on the market, their applicability and costs. It was found from those consulted that traps with pheromonal capacity are more expensive but much more effective than those whose attractive element is color or other characteristics. Also, the sex ratio was taken into account in our advisory study and it was found that both females and males are attracted to available traps. At the same time, we wanted to summarize available solutions for monitoring and determining the dynamics of adult populations and highlight the essential points from which any farmer can start the action of population evaluation of adults in their corn crops.

Keywords: trap type, adults, *Diabrotica*, corn crops, market.

INTRODUCTION

First described in 1868 by LeConte and first reported as a pest in 1909 in Colorado (KRYSAN, 1986), *Diabrotica v. virgifera* is widely spread in nowadays, being a very damaging pest in corn fields. In Europe it was firstly reported near Belgrad, in early 1990's and by the late 1990's it was established a monitoring network, with the input of Hungary, Romania, Croatia, former Yugoslavia and Bulgaria, whose purpose was to signal the presence, including monitoring, of western corn rootworm (WCR). For this purpose, for interested countries, traps based on cucurbitacin, Multigard® sticky yellow panel and traps with sex pheromones were supplied by Purdue University from Indiana, USA and the Institute for Phytomedicine - H.K. Berger from Vienna, Austria, (KISS ET AL, 2005). In addition, visual inspection of the plant was required.

In 1997, FAO initiated Technical Cooperation Programme (TCP), a project which involved tracking *Diabrotica v. virgifera*, with the aim of determining its occurrence and spread in European countries and assessment of the annual evolution. Within TCP, for catching males were used Csalomon® traps, provided by Plant Protection Institute from Budapest, and for females Multigard® panels (KISS ET AL, 2005). Later, the Multigard® panels were replaced with yellow sticky panels from Trécé Incorporated, called PHEROCON®.

The monitoring of the adult population of WCR it's a continuous activity, both in areas where WCR presence is known and in areas where it has not been yet reported. Monitoring plays an important role in building control and eradication strategies in areas where pest is indicated for the first time. Where the population level is high and known, monitoring is a useful tool in developing trapping tools and pest control solutions, but also for crop management measures, like chemical control, to minimize production losses.

There are many authors in the specialized literature who mentioned or described in their papers tools used for monitoring and trapping WCR, as sticky sheets, container, baited traps, equipped with floral lures and sex pheromones (KUHLMANN & BURGT, 1998; SHAW & HUMMEL, 2003; TÓTH ET AL, 2003; SCHAUB ET AL, 2011, DINNESEN ET AL, 2015; MANOLE ET AL, 2017; TOSHOVA ET AL, 2017; TÓTH, 2017; GROZEA, 2003; GROZEA, 2010; GROZEA & COSTEA, 2022; GROZEA ET AL, 2024).

These traps are used these days by researchers who want to learn more about the evolution and spread of the beetle, so, through this article, we proposed to pass in review the types of traps currently available on the market, with a short description and cost effectiveness.

MATERIAL AND METHODS

For this study, numerous sources were consulted, as books, scientific articles and producer's websites, over a period of three weeks, during september and october 2024. Electronic sources were found through Google Scholar, being reliable sources, such as scientific journals, recognized and frequently cited by the authors. On the manufacturer's websites are available descriptions of each individual instrument, very useful for this study. The material found was structured in a simplistic way, using tabular centralization and information synthesis.

RESULTS AND DISCUSSION

The analyzed sources pointed out that several types of traps are available on the market in different shapes, colors, with various methods to bait WCR, using known stimuli, such as visual ones (yellow color) and olfactory ones (food, floral or pheromonal attractants), each of them having advantages and limitations.

Visual traps, which do not use floral baits or pheromones, are less attractive but effective for determining of pest presence. Though, to increase efficiency this tools can be used together with attractants.

Cucurbitacin-based traps use a feeding stimulant, in the form of a small tube, filled with dry plants and insecticide. The plant material is rich in cucurbitacin and is coming from *Cucurbita spp.* This compound is not an attractant, but food for WCR.

Pheromones used in baited traps are species-specific (meaning they are effective only in attracting *Diabrotica virgifera* adults and no other insects) and contain synthesized chemicals that mimic the natural pheromones emitted by pests, attracting opposite sex adults to the trap. They are designed to be selective, meaning they attract only males or only female adults.

Floral attractants are compounds extracted from pumpkin flowers, which addresses both female and male beetles. They are used together with the sticky sheets, preferably transparent, to have an increased efficiency. They are not as sensitive as pheromonal ones and ratio between females and males is not balanced (catches mostly females).

Types of traps

The most popular visual-based traps are the yellow sticky panels, which are very accessible, simple and easy to install. Their effectiveness is given by the constructive elements - the yellow color that attracts insects and the glue that captures and immobilizes them. They can be fixed onto supports or plant branches, at 1-1.5 m height. The sheet is graded, thus facilitating the process of quantifying the captured beetles.

Yellow sticky panels are used to signal the presence or absence of *Diabrotica virgifera*, monitor pest population dynamics and have as a consequence the reduction of the population. They have the advantage of catching both sexes of WCR, but also the disadvantage of catching non-target insects, which are attracted by the panel's color. Many companies produce this type of traps, most used are:

- Scentry Biologicals INC., product found under the name MULTIGARD®;
- Trécé Incorporated, USA, product found under the name Pherocon® Unbaited AM;
- Serbios SRL, Italy, product found under the name Diabrotica Track.



Figure 1. Types of yellow sticky panels, by manufacturer (from Scentry Biologicals, Trécé Incorporated and Serbios)

Although adhesive panels can be used in conjunction with pheromones (produced by the same manufacturer) to increase the catch, other tools have been developed with great effectiveness and the most established at the european level are Csalomon® traps, provided by Plant Protection Institute, from Budapest, Hungary. They come in the form of a sticky, transparent sheet and a container, both outfitted with pheromone or floral lures.

Transparent sticky sheets have a simple design, with adhesive on one side, while the other side is non-sticky. They are easy to install, must be wrapped around the plant or a wooden pole, with the glue on the outside and the bait dispenser placed on the top edge. When used with floral lures, the catches are predominantly females, when used with sex pheromone (PAL) the catches are male only. For this type of traps, the manufacturer indicates a catch capacity of 300-400 beetles (from Csalomon). The sticky sheet can also come colored in bright yellow, but in this case the accuracy of the catches decreases. Manufacturer sales the yellow sticky sheet together with floral lure (PALs).



Figure 2. Transparent sticky sheets pheromone (left) and floral (right) lures (photographed by Purice D.)

Container traps, also called „hat” traps are fitted with a receptacle (that allows insects to pass through, but prevents them from exiting) and a non-sticky panel, colored in bright yellow. They

are built from durable materials and are equipped with floral lures (KLPflor+) or sex pheromone (KLPfero+), placed on panel's top. Inside, there's a mechanism to retain the insects (insecticidal or sticky strips) until they are collected and evaluated. Sticky strips are provided by the manufacturer along with the trap and insecticidal strips can be purchased separately (ex. Vaportape® from Hercon Environmental Inc., Emigsville, PA, USA)

Hat traps are very effective tools, both for detection and monitoring; They have a very large catching capacity of 5-6000 thousand beetles. These traps have the advantage of being used for several years, with replacement of the bait and retaining mechanism.



Figure 3. Csalomon container trap (photographed by Purice D.)

Delta traps are shaped like a triangular prism and are air suspended (on branches or other supports, with wires). They are equipped with chemical attractant to increase insect-catching effectiveness.

This type of traps are made of biodegradable white cardboard, with a sticky film inside. The lures provided are rubber dispensers impregnated with sex pheromones to attract males.

These tools are offered for sale by two manufacturers from the Republic of Moldova:

- Mezhtans Moldova S.R.L., product found under the name EcoCenter;
- Biochemtech S.R.L., product found under the name Insecto™ Pheromone Traps.



Figure 4. Delta traps (from EcoCenter and Biochemtech)

It should be mentioned that they are not the most suitable for WCR, opened ones being optimal.

Roof-type traps are also a solution available on the market for WCR. "Raluca Ripan" Institute for Research in Chemistry (ICRR) from Cluj Napoca, Romania, developed a pheromonal

trap composed of a white polypropylene plate with one side sticky and the bait (consisting of a rubber dispenser impregnated with sex pheromones emitted by female to attract males). The bait is placed in the center of the adhesive surface, using gloves, to avoid their contamination. ("Raluca Ripan" Institute for Research in Chemistry).



Figure 5. Roof-type trap from "Raluca Ripan" Institute for Research in Chemistry (photographed by Purice D.)

A summary of the described traps, together with their most important characteristics, can be found in Table 1. Also, in the graph below it can be analyzed what cost implies each tool (in Figure 6).

Table 1

Most used traps and their features

Type of trap	Attractive items			Sticky	Ratio male/female
	Visual	Sex pheromone	Floral lure		
Csalomon PALs	applicable	without	applicable	applicable	mostly female
Yellow panel Pherocon, Diabrotica Track, Multigard	applicable	without	without	applicable	mostly female
Csalomon PAL	without	applicable	without	applicable	male
Csalomon KLPfero+	applicable	applicable	without	without *	male
Csalomon KLPflor+	applicable	applicable	applicable	without *	mostly female
Delta, EcoCenter, Insecto™ Pheromone	without	applicable	without	applicable	-
Roof type, ICCRR	without	applicable	without	applicable	-

*Sticky strip can be placed inside

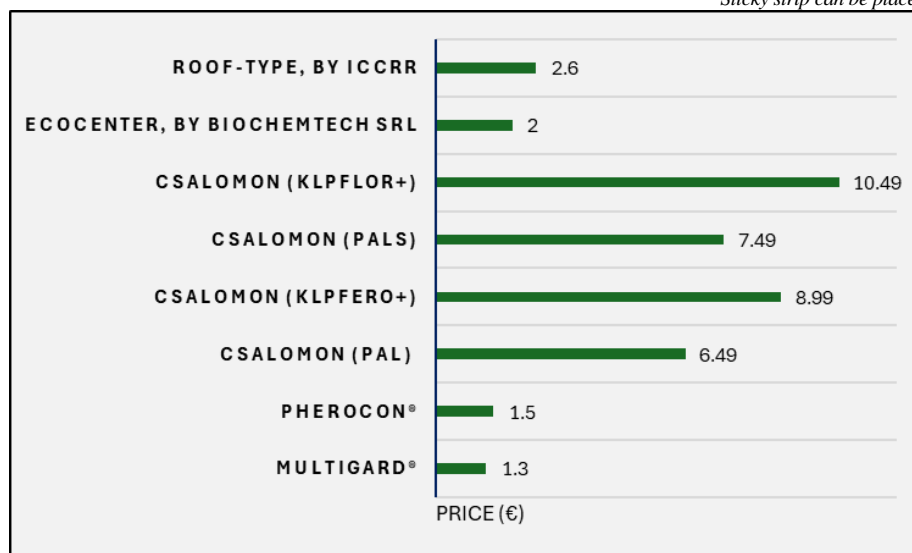


Figure 6. Traps price analysis

CONCLUSIONS

This study shows that there are several traps *Diabrotica v. virgifera* on the market, some of them with great efficiency, like pheromonal ones, and others with not so high accuracy, as yellow sticky panels. Even so, all can be used in order to detect, monitor the distribution and the activity of WCR adults and also to provide information useful for a pest management plan (optimal timing to apply insecticides).

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