

HOST PLANTS FOR THE WESTERN CORN ROOTWORM *DIABROTICA VIRGIFERA VIRGIFERA* (COLEOPTERA: CHRYSOMELIDAE)

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ABSTRACT

The western corn rootworm found favourable life conditions in Europe. Proof for that is the changing population dynamics starting with the 90's up to present times. Due to its spreading and to the damage it can do to corn, certain measures to eradicate the pest are necessary. If no measures are undertaken, the damage to the maize crops can be considerable. Applying the correct pest control measures depends on certain factors, including the knowledge about alternative host plants. In our paper we investigated, in field conditions, the presence of already existing *Diabrotica virgifera virgifera* LeConte populations on various weeds one can find in a maize field, such as *Agropyron repens*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata*, *Setaria viridis* and *Sorghum halepense*. We also tested, under the same circumstances, two cultivated plants *Triticum aestivum* and *Hordeum vulgare*.

Key words: Host plants, western corn rootworm, *Diabrotica virgifera virgifera*.

INTRODUCTION

Maize cultivation is practiced on the largest surfaces at a global level. In Romania, maize covers approximately 60% of the total cultivated surfaces. Its importance is shown by its uses in the food industry, by the great corn product variety (Ionescu-Șișești, 1955), a fact which is still applicable nowadays. On the other hand, maize is a relatively good predecessor for other crops, it presents a high productivity and it allows advanced mechanization.

In time a lot of insects have used maize as a host. They have been seen as pests because of the damage they produced to the crop. Among these pests we name: *Ostrinia nubilalis*, *Helicoverpa armigera*, *Agrotis segetum*, *Loxostege sticticalis*, *Tanimecus dilaticolis*, *Agriotes lineatus*, *Opatrum sabulosum*, *Anoxia villosa*, *Pentodon idiota*, *Popillia japonica*, *Rhopalosiphum maydis*. Today, *Diabrotica virgifera virgifera*, a pest originating from North America, which reached Europe in the 90's, brings considerable damage to maize crop. A genetic analysis showed that its arrival to Europe was

completed in various stages, at five different, independent entrance points (Serbia, Italy, France in two locations and Great Britain), with two intra-continental penetrations, from Serbia to Italia and from Great Britain to France (Ciosi et al., 2008). It is estimated that the annual damage that this pest can produce on our continent will be up to half a billion Euros (Harmuth, 2005; Baufeld et al., 2006; Wesseler and Fall, 2010). EPPO reports show that, at present, the insect is located in Serbia, Hungary, Croatia, Romania, Herzegovina, Bulgaria, Italy, Switzerland, Ukraine, Austria, France, Czech Republic, Great Britain, Holland, Belgium, Slovenia, Poland, Germany, Belarus and Greece. We estimate that in the following years *Diabrotica virgifera virgifera* LeConte will spread to the entire maize crop areas in Europe (Fora, 2011). These are the reasons why effective pest control measures against the insect should be undertaken.

It was observed that the number of *Diabrotica virgifera virgifera* LeConte beetles in a cornfield without weeds is lower than in a corn field with weeds (Fora, 2011). It is a common knowledge that some spontaneous plants which appear in a maize field are a food

source for the *Diabrotica virgifera virgifera* LeConte, but it was not yet established which plants are these, and the way in which they influence the pest is also not yet known. Laboratory tests have showed that the pest larvae can develop on *Hordeum vulgare*, *Triticum aestivum*, *Triticum spelta*, *Oryza sativa* (Branson and Ortman, 1967 and 1970). Also, in field conditions they can grow on *Triticum aestivum* (Branson and Ortman, 1967 and 1970). Moeser and Vidal (2004) published the analysis results of the food range of *Diabrotica virgifera virgifera* LeConte beetles and concluded that, aside from maize pollen, pollen from the following species could also be identified: *Amaranthus* sp., *Chenopodium album*, *Ambrosia artemisiifolia*, *Cirsium arvense*, *Helianthus annuus*, *Sonchus asper*, *Xanthium strumarium*, *Cucurbita maxima*, *Medicago sativa*, *Malva sylvestris*, *Echinochloa crus-galli*, *Setaria pumila*, *Setaria verticillata*, *Sorghum halepense*, *Sorghum bicolor*, *Linaria vulgaris*, *Datura stramonium*. Breitenbach et al. (2005, 2008), indicated as alternative host plants the following species: *Setaria viridis*, *Setaria verticillata*, *Setaria glauca*, *Elytrigia repens*.

The purpose of our research was to identify alternative host plants for the *Diabrotica virgifera virgifera* LeConte in the conditions of Western Romanian crops and to see how they can influence the pest populations. This paper presents the results of rigorous experiments, carried out in the field in the periods 2005-2007 and 2009-2011. The studied weeds were: *Agropyron repens*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata*, *Setaria viridis* și *Sorghum halepense*. The studied cultivated plants were: *Triticum aestivum* and *Hordeum vulgare*.

MATERIAL AND METHODS

The study area

The research was conducted in the maize fields of the Lovrin and Grabaț localities from the county Timiș, where the pest found favourable life conditions. The relief of this area is one of lowland with Aeolian loess deposits. The groundwater level is situated

between 1.5 and 3 m. The dominant soil type in the research area is chernozem containing loess, loess deposits and clay types (Pușcă, 2002). The climate resembles the steppe climate, characterized by annual medium temperatures of 10.8°C, with a high number of tropical days. The medium precipitation quantity is of only 544.3 mm. The number of rainy days is under 110. After Köppen, the climatic formula is: c.f.a.x., which represents a medium climate with mild winters, early springs, warm summers and long autumns (Pușcă, 2002). The spontaneous vegetation presents steppe elements with absinth varieties and xerophytic cereal pastures (*Festuca*, *Poa*, *Aegilops cylindrica*). In row crops we encounter: *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Sorghum halepense*, *Xanthium strumarium*, *Cynodon dactylon*, *Ambrosia artemisiifolia*, *Cirsium arvense*, *Setaria* ssp., *Hibiscus trionum*, *Thlaspi arvense*, *Chenopodium hybridum*, *Chenopodium album*, *Fumaria officinalis*, *Bromus tectorum*, *Bromus sterilis*.

The field experiment was carried out in a maize field naturally and significantly infested by *Diabrotica virgifera virgifera* LeConte. During all experimental years, after the soil was prepared by ploughing at approximately 25 cm depth, disking and fertilizing, in autumn the winter crops (wheat and barley) and the studied weeds were seeded. In spring maize was seeded, using seeds which were not treated for pest control, with 6 plants m⁻².

After emergence isolators were installed, each with a basic effective area of 1 m², and inside them all agro-technical and agro-chemical treatments for crop care were carried out. Isolators were built during the first years from wood and in the last year from a metal ribbon in the shape of a circle, which represented the part which fixed the isolator to the ground. In its midst a 1.6 m high pole was fixed. On this frame a net was placed, with loops of 0.2 mm, in order to prevent adults from entering or exiting. The net was anchored on the wooden frame or on the metallic ring fixed in the soil and its upper part was fixed on the pole. The thus constructed isolators had a lateral zipped entrance for visitors.

The experimental variants were: *Zea mays* (nontreated control); *Agropyron repens*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata*, *Setaria viridis*, *Sorghum halepense*, *Triticum aestivum* and *Hordeum vulgare*. Each variant had four replications.

Catching of beetles

On the pole in the middle of each isolator yellow adhesive traps were placed. The traps were checked periodically and the beetles were retrieved. A part of the beetles were retrieved manually from the inside of the isolators. After being caught, the beetles were introduced in plastic recipients numbered and dated, and subsequently, in the laboratory, they were counted and biometrically measured.

Statistical analysis

The results were statistically interpreted with the help of the variance analysis, utilizing the Duncan test for multiple comparisons.

RESULTS AND DISCUSSION

The species *Diabrotica virgifera virgifera* LeConte was found, in field conditions, aside from maize, on *Agropyron repens*, *Digitaria sanguinalis*, *Echinochoa crus-galli*, *Setaria glauca*, *Setaria verticillata* and *Setaria viridis* (Figure 1). The only spontaneous plant species accompanying maize, on which no beetles were found was *Sorghum halepense* (Figure 1). On the roots of this weed only initial larvae gnawing was observed, which was soon abandoned. This fact confirmed the findings of Clark and Hibbard (2004) and of Branson and Ortman (1969) who detected that cane was toxic for the western corn root worm. In our opinion, the larvae L₁ do not, at this stage, present a strong enough oral apparatus in order to penetrate the *Sorghum halepense* root, which is rich in silicon, and thus harder. Given this situation, the larvae L₂ and L₃ seek another accessible food resource in the ground. There were significant differences between the

control variant (untreated maize) and the other variants, from the point of view of the captured beetle number. This behaviour underlines the species preference for maize and the fact that it can also develop on spontaneous gramineous weeds accompanying agricultural crops, even if it does not encounter the best life conditions. The existence of sub optimal life conditions influences the dimensions of the adults. Ellsbury et al. (2005) showed that the average size of adults growing on *Setaria* weeds was smaller. From our own measures carried out upon adults, we were able to conclude that the food source was closely connected to the beetle size. Beetles whose larvae fed on the root of *Agropyron repens*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata*, *Setaria viridis*, were smaller in comparison with beetles whose larvae fed on maize roots.

From the studied weeds, the ones ensuring the most favourable life conditions for the pest were: *Setaria viridis* closely followed by *Echinochloa crus-galli* and *Digitaria sanguinalis*. There were no significant differences between the captures of these three variants. *Setaria glauca*, *Setaria verticillata* and *Agropyron repens* were less favourable. Differences were significant between the three former variants and these latter ones. Compared to the control, the *Diabrotica virgifera virgifera* LeConte populations were smaller, with capture values smaller by 86.3% in *Setaria viridis*, 87.5% in *Echinochloa crus-galli*, 88.4% in *Digitaria sanguinalis*, 94.5% in *Setaria glauca*, 95.4% in *Setaria verticillata*, 98.2% in *Agropyron repens*, and 100% in *Sorghum halepense*, *Triticum aestivum* and *Hordeum vulgare*.

If we add the number of beetles captured on *Agropyron repens*, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata* and *Setaria viridis*, the obtained value represents almost 50% of the number of beetles captured on the control (*Zea mays*). This fact proves that the survival of the western corn root worm is ensured in the pedo-climatic conditions of Western Romania, even in the absence of corn.

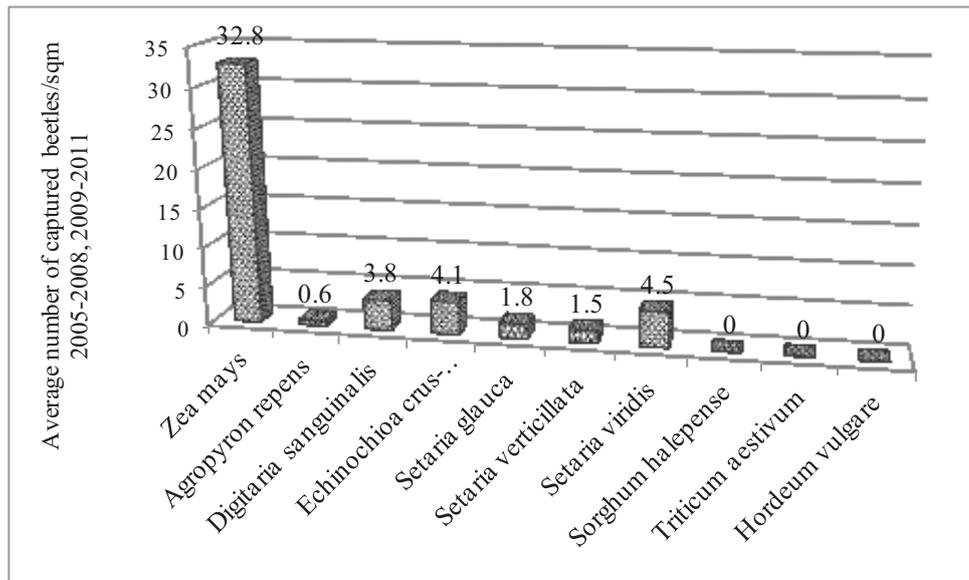


Figure 1. Host plants for *Diabrotica virgifera virgifera* LeConte

In field conditions *Diabrotica virgifera virgifera* LeConte did not develop on *Triticum aestivum* and *Hordeum vulgare*. During the entire experimental period no capture was registered with either variant (Figure 1). The same result was obtained by Breitenbach et al. (2005) as well, and contradicts the results obtained by Branson and Ortman (1967 and 1970), which indicated that wheat functions as a host for the studied pest in field conditions.

Rotating maize with wheat and barley can determine a reduction in the *Diabrotica virgifera virgifera* LeConte population level, so that no economic damages occur. Despite this fact, where maize neighbouring wheat fields covers large areas, some females may lay eggs in the neighbouring wheat stubble field, ensuring a reserve for the following year. The introduction of three or four crops in the crop rotation system, so that maize is re-cultivated over a year later may have a positive effect in the drastic reduction of the pest population level.

Diabrotica virgifera virgifera LeConte larvae cannot survive more than one day in saturated water soils, due to the lactic acid accumulation (Hoback et al., 2002). From our own observations of a spray-irrigated corn field in 2-3 leaves stage, at Valcani, Timiș County, we could infer that larvae L₁ of the western corn root worm are very sensitive to the humidity excess and die. At the same time, in the non-irrigated section of the field, an

attack was signalled. In the previous year, in the same spot, the culture was also maize and the *Diabrotica virgifera virgifera* attack was rather strong.

CONCLUSION

As a result of the research carried out in field conditions on the western Romanian lowlands, during the periods 2005-2008 and 2009-2011, regarding alternative host plants for *Diabrotica virgifera virgifera* LeConte, the following conclusions could be drawn:

Agropyron repens, *Digitaria sanguinalis*, *Echinochloa crus-galli*, *Setaria glauca*, *Setaria verticillata*, *Setaria viridis* are host plants for the pests.

The life conditions were ensured, aside from corn, by the species: *Setaria viridis*, *Echinochloa crus-galli* and *Digitaria sanguinalis*.

Less favourable conditions, which nevertheless allowed the survival of the species, were ensured by *Setaria glauca*, *Setaria verticillata* and *Agropyron repens*.

Sorghum halepense, *Triticum aestivum* and *Hordeum vulgare* are not host plants for the insect.

Keeping the maize field free of weeds can reduce the western corn rootworm population level.

The introduction in the crop rotation system of winter and spring small grain

cereals has a direct effect on the western corn rootworm population dynamics.

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