WESTERN CORN ROOTWORM AND EUROPEAN CORN BORER – FLIGHT DYNAMICS IN VOJVODINA PROVINCE, SERBIA

Snežana, TANASKOVIĆ[1], Branka, POPOVIĆ[1], Sonja, GVOZDENAC[2], Z. KARPATI[3], C. BOGNAR[3], M. ERB[4]
[1]University of Kragujevac, Faculty of Agronomy in Čačak, Cara Dušana 34, Čačak, Serbia
[2]Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Srbija;
[3]Plant Protection Institute Hungarian Academy of Sciences, Budapest, Hungary
[4]Functional Plant Biology, Institute of Plant Sciences, University of Bern, Switzerland
Corresponding author: (stanasko@kg.ac.rs)

Abstract. *Western corn rootworm (WCR) and European corn borer (ECB) coexist in the Serbian maize fields for the last 25 years. It is poorly known how does the WCR, as a soil dwelling insect, influence the appearance and abundance of ECB population in the same field and vice versa. Three-year experiment was conducted in Bečej, Vojvodina province, Serbia. Aim of the study was to determine the flight dynamics of WCR and ECB under artificial infestation with WCR eggs, and preliminary indentify ECB strain in pheromone traps. During three years, the presence of different ECB strains was verified. Population dynamic, according to obtained data, indicate high differences in population abundance. The occurrence of this pest in the field fluctuates. The earliest catch was on 2nd June (2016) and the latest on 17th July (2014). In 2015, when the highest temperature and the lowest humidity were registered, the first ECB specimen was caught on 23rd June. The last catch of moths was earlier in vegetation on 20th August (2014) and the latest on 9th October (2016). In 2015, the last catch was on 10th September. Preliminary results signify the presence of Z pheromone race in the north part of Serbia. Flight of WCR fluctuates during experimental years. The first catch was registered during the first week of July, and last in August 2014-2015, i.e. September 2016. The WCR highest catch, 181 specimens, was recorded during the last field inspection, on 30th September 2016.*

Keywords*: European corn borer, Western corn rootworm, pheromone traps, flight dynamics, pheromone races,*

INTRODUCTION

European corn borer (ECB), *Ostrinia nubilalis* Hbn. (Lepidoptera, Pyralidae) and Western corn rootworm (WCR), *Diabrotica virgifera* sp. *virgifera* Le Conte (Col., Chrysomelidae) represent widely distributed pests in Europe and North America, today (TALLAMY ET AL., 2005; BERMOND ET AL., 2012; EPPO, 2015). Since early 1990's, producers shared the management challenges for this enemy of maize fields.

WCR is an oligophagous pest, native in Central America (KRYSAN AND SMITH, 1987). The first identification of WCR in Europe was near the Belgrade airport, Serbia in 1992 (BAČA, 1993). However, new evidence resulting from molecular studies implies multiple introductions in Europe (CIOSI ET AL, 2008). This indicates that the European populations do not all originate from the first introduction in Serbia, i.e. that this belief was false. Nowadays, WCR is present in almost every maize field in Europe (KISS ET AL., 2005; HUMMEL ET AL., 2008; BERMOND ET AL., 2012). WCR belongs to a group of soil dwelling pests, whose larvae attack roots, while imagoes feed on above-ground parts of maize (Ciobanu et al., 2009) and highly influence maize production. The presence of larvae in the field causes the loss of root tissue and thus the impossibility for maize to take water and nutrients (CHIANG, 1973; WESSELER AND FALL, 2010; IVEZICH ET AL., 2011). WCR larvae are feeding on the nodal and lateral roots (GAVLOVSKI ET AL, 1992). Goose necking (GN) is the main symptom which indicates the presence of WCR larvae in maize field (CHIANG, 1973; WESSELER AND FALL, 2010). Plant lodging is a clear/definite manifestation of WCR infestation and it can lead to yield losses (TOLLEFSON, 2007). Damages of WCR are highly depended on a number of larvae in soil, soil moisture, the type of soil, environmental conditions (SPIKE AND TOLLEFSON, 1989; CIOBANU ET AL., 2009).

European corn borer (ECB), *Ostrinia nubilalis* Hbn. (Lepidoptera, Crambidae) is a pest present worldwide in maize fields (OERKE ET AL., 1994). It is one of the most destructive and economically important maize pests (KOCMÁNKOVÁ ET AL., 2008; RASPUDIĆ ET AL., 2013). This insect is a polyphagous herbivore (Mason et al., 1996), which can feed and reproduce on more than 224 plants (LEWIS, 1975; PONSARD ET AL., 2004). The presence of ECB in European entomofauna was established around year 1500's (BETHENOD ET AL., 2005). The first identification of ECB as economically important maize pest in Europe dates back in XIX century, i.e. 1835, in France (COFFREY AND WORTHLEY, 1927). ECB occurs from June to August, with the highest activity during night. ECB moths live 10 days in average (HILL, 1987), while adult's longevity and fertility increases in conditions of high humidity and good nutrition (LEAHY AND ANDOW, 1994). Population dynamic of ECB is highly influenced by climatic conditions (BAČA ET AL., 2002; POPOVIĆ ET AL., 2016; TANASKOVIĆ ET AL., 2015; 2017). Also, vegetation, variety, growing technology, cropping system and production of maize in the region has a strong influence on ECB biology. From mostly univoltine pest in Balkans during eighties of XX century, ECB was identified as polivoltine insect (Hadžistević, 1983). In Serbia, ECB represents economically very important maize and pepper pest (KEREŠI ET AL., 2004; KEREŠI AND ALMAŠI, 2009; EPPO, 2014), and in Slovenia a pest of maize and hop (RAK CIZEJ ET AL., 2013).

MATERIAL AND METHODS

The field experiment was carried out in Bečej, Vojvodina province, Northern Serbia. It was performed from May to September 2014, 2015 and 2016. The Serbian cultivar NS-640 was used in each year of the experiment. The chosen filed for experiment represents the filed with low WCR natural infestation.

During the experiment, 96 maize plants were selected, labelled and arranged into pairs. The plants are set up in two rows, with 1 m distance between labelled plants. In each pair, one plant was artificially infested in root zone with 4 mL of WCR eggs 0.125% agar suspension (D plant). One mL of suspension contained 136 WCR eggs. The other plant from the pair was the control plant (C plant) in which root zone, the same amount of distilled water (4 mL) was injected.

After the artificial infestation, pheromone traps for WCR and ECB were placed in the field. WCR trap was set in the middle of selected maize plants rows. Deployed pheromone traps (ANDERMATT, Biocontrol – Switzerland) were installed during June in all three vegetation years. Sticky bases were cleaned or replaced, depending on the number of caught specimens.

Pheromone traps (5 replicates per each race and for control) for ECB were positioned on the edges of maize field. During the experimental period (2014-2016), the traps were deployed at the beginning of the vegetation, i.e. on 26th June, 23rd and 25th May, respectively, depending of sowing period per vegetation. Pheromone traps were used for all three different races of ECB (Z, E and H) and empty traps as control traps, labelled with C, were placed as well. Traps are obtained from Institute for plant protection, Budapest, Hungary. They were labelled according to lure i.e. E - strain lures (1:99 Z11-14Ac: E11-14Ac), Z-strain lures (97:3 Z11-14Ac: E11-14Ac), H –strain lures (50:50 Z11-14Ac: E11-14Ac) and C – control or empty traps. On sticky bases for all traps, RAG egér (BIOTOLL) was used as a glue.

The field was inspected every week for three, four or five months (depending on the experimental year). In each filed inspection, sticky bases in all type of pheromone traps were inspected as well, the presence of WCR and ECB was recorded and sticky surfaces were replaced.

RESULTS AND DISCUSSIONS

Regular inspection during experimental period indicates the presence of specimens of WCR and ECB at sticky bases of pheromone traps. Behavior and flights of both pests were different as a consequence of different climatic conditions. In general, 2015 represents very dry vegetation with extremely high temperatures over the summer season (especially during July and August).

WCR flight dynamics

In the first experimental year (2014) the inspections show that the number of WCR caught specimens was progressing during the vegetation. The smallest number of caught specimens (Figure 1) was registered at the beginning of vegetation i.e. 2nd July (2 specimens). The highest registered catch with 22 specimens on sticky bases was at end of vegetation (18th September).

During 2015, more specimens were caught then in the previous year (Figure 1). Inspection of sticky bases in 2015 indicates that WCR flight fluctuated during vegetation period. The highest number of caught specimens was in middle of vegetation (6th Avgust 2015) when the presence of 71 WCR adults was recorded. At the end of vegetation (10th September) the smallest number of WCR adults (1 specimen) was recorded.

In 2016, continuous flight was registered from 2nd July until 30th September. At the beginning of August (4th Avgust) the first peak (99 specimens) was registered. The highest number of caught specimens in weekly inspections (181) was registered on 30th September. During this vegetation, the highest total number of caught WCR males (559) on sticky bases was recorded, while during 2014 and 2015, the number of caught males in pheromone traps was 91 and 216 specimens, respectively.

The results of Sivcev et al. (2009) indicate that the highest number of caught adults in pheromone traps was in the period of 25th July - 15th August in Serbia. The highest number of caught WCR adults (22) in Bečej, in 2014, was on 19th September, in 2015, on 6th August (71 adults) and in 2016 on 30th September (181 specimens). The results are presented on Figure 1. In 2015 the first catch in Bečej was on 9th July and the last was on 10th September. Investigation (TOTH ET ALL., 1996; TOLLEFSON, 2007) shows that the highest efficiency of pheromone traps was in the mid vegetation, with daily catch of 6 WCR adults. On the other hand, during the vegetation period from 27th August to 10th September, not a single imago was registered in traps in Zemun polje (TANČIĆ ET ALL., 2006). Our experiments and many other studies indicate the progressive and fluctuating catch of adults of WCR in different vegetation periods.

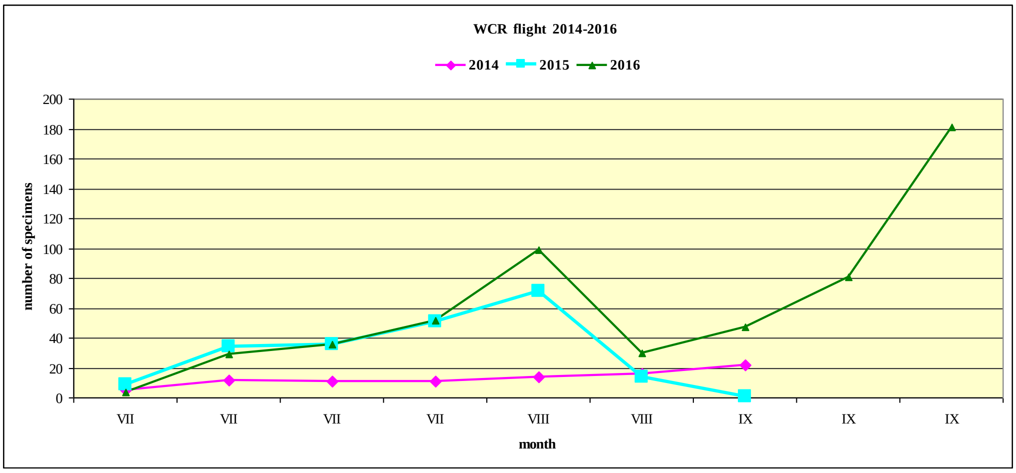

Figure 1. Western corn rootworm flight dynamics in Bečej, Vojvodina province, Serbia

ECB flight dynamics

According to the obtained data, the number of caught ECB specimens in pheromone traps was fluctuating and progressing during vegetation period in 2014, 2015 and 2016.

In 2014, the highest number of caught specimens (Figure 2) was on 14th August (14 specimens) and the lowest in the last catch, on 20th August (1 specimen). The first registered catch was on 17th July (1 specimen).

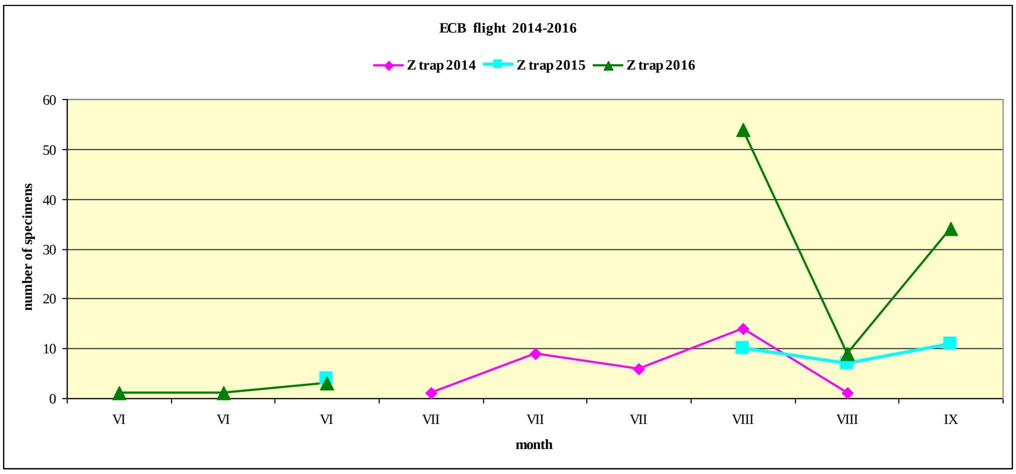

Figure 2. European corn borer flight dynamics in Bečej, Vojvodina province, Serbia

During vegetation period in 2015, the number of caught ECB was progressing (Figure 2). The first catch and at same time the lowest one, was on 23rd June (4 specimens) and the highest and also the last catch in vegetation was on 10th September (11 specimens). During vegetation period in 2016, the flight of ECB was fluctuating. The first catch on sticky bases in pheromone traps was earlier than in previous experimental years. The first specimens (3 specimens) in this vegetation period were caught at the begging of June (2nd June). The last caught moths (34 specimens) were recorded on 10th October. The highest number, of 54 caught specimens, in 2016, was registered on 16th August. On 9th June 1 specimen was caught and it represents the lowest number of caught moths at sticky bases in this vegetation.

The use of phero-traps has several advantages, compared to other sampling methods, namely, more often used light traps. According to BEREŚ (2012), pheromone traps enable catches of moths five days earlier than in light traps. However, ŻOŁNIERZ AND HUREJ (2007) report that significantly higher number of moths was caught in light traps, compared to pheromone traps. This is expected because light traps catch all nocturnal species on a wider region.

According to ČAMPRAG (2002) AND VAJGNAD (2010), the flight of the first generation was registered on 1st May and the flight of the second generation was in the mid of July - beginning of August. During our research period, the first catches were on 17th July 2014, 23rd June 2015 and 2nd June 2016, which is in compliance with catches of the second generations according to ČAMPRAG (2002) AND VAJGNAD (2010). Using the pheromone traps, BEREŚ (2012) had the first catches in Poland between 27th and 28th June (2007 - 2008).

The obtained results indicate that in Bečej region, ECB is bivoltine insect. In Vojvodina province during vegetation period 2008 and 2010, ECB had three generation per year (VAJGNAD, 2010). Depending on climatic conditions in vegetation period, the number of ECB generations per year in Croatia varies from one to two incomplete (MACELJSKI, 2002 CIT. IN BAZOK AND IGRC BARCIC, 2010). According to GOMBOC ET AL. (1996), ECB in Slovenia, there are two generations in continental part and three generations in the coastal region.

Cold period is more suitable for ECB flight than the warm, rainy periods with hot and humid weather (KANIA, 1961). This indicates that climatic factors have significant influence on population dynamic and ECB flight (KIMMINS, 1987). According to those data it could be concluded that prolonged or extended flight in 2016, compared to previous years, is a consequence of lower temperatures in the second part of the vegetation. Shortest flight activity was registered in 2014 (17th July– 10th September) and 2015 (23rd Jun - 20th August). Differences in the total number of caught specimens per vegetation i.e. 31 (2014), 52 (2015) and 102 (2016), indicate at progressive population increase. The prevalent number of caught moths belongs to Z strain. In 2014, only catches on Z traps were registered. However, in 2015 and 2016, catches were also registered on H (2015) i.e. H and E traps (2016). These results represent preliminary identifications of ECB strains presence in maize field in Bečej region. Detailed GS-MS analysis will confirm to exactly which strain belong the caught specimens in Bečej field.

CONCLUSIONS

According to the presented results, the number of caught WCR males and ECB moths in pheromone traps was fluctuating and progressing during vegetation periods in 2014, 2015 and 2016. The number of caught WCR males in phero-traps differed between the years. 91 specimens were caught in 2014, 216 specimens in 2015 and 559 in 2016, indicating increase in this pest population. The differences in the total number of caught ECB moths per vegetation, i.e. 31 (2014), 52 (2015) and 102 (2016), indicate at progressive ECB population increase. The prevalent number of caught ECB moths belongs to Z strain.

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