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# LEVEL OF LARVAL ATACK ON MAIZE ROOTS AS A CONSEQUENCE OF ARTIFICIAL INFESTATION WITH WESTERN CORN ROOTWORM EGGS

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## ABSTRACT

The Western corn rootworm (WCR), *Diabrotica virgifera* sp. *virgifera* (Col.,Chrysomelidae), is an oligophagous pest native in America. WCR is a maize pest present in all regions of the Corn Belt. It is an invasive species which was, in Europe, first identified in Serbia, in 1992, near the Belgrade airport. The presence of this pest in maize field can cause losses and plant damages up to 100%. A field experiment was carried out in Bečej, Vojvodina province (Serbia), during 2014 and 2015. In the field, 96 plants (maize cultivar NS 640), arranged in 48 pairs were selected. Each pair consisted of one plant artificially infested with WCR eggs (D plant) and the control plant (C plant). In both years, the experiment in the field was regularly inspected, once a week. During each observation, the presence of "goose neck" symptoms was recorded, and the number of plants damaged by the most important stem boring and leaf feeding insects (*Ostrinia nubilalis*, *Helicoverpa armigera*, *H. zeae*, aphids, mites, cicadas, etc. ) was counted. Root damages were assessed at the end of the experiment (September), according to Ostlie and Notzel (1987), on scale 1-6. Comparing the root damages on C and D plants, less root damages were established on C plants. Only six i. e. four D plants had healthy roots (rate 1) during 2014 and 2015, respectively. Between D plants in 2014, the most damaged were14 plants, with the rate 3 (least one root chewed to within 1½ inches (3. 8 cm) of the plant). In 2015, severe damages were registered on 18 plants, which were ranked as level 6 (with three or more nodes destroyed). Only two C plants during vegetation 2014-2015were registered with damages with rate 5 (two nodes destroyed) and rate 6 (three or more nodes destroyed), respectively.

**Key words:***Maize, WCR, Artificial infestation, Root inspection, Damages.*

## INTRODUCTION

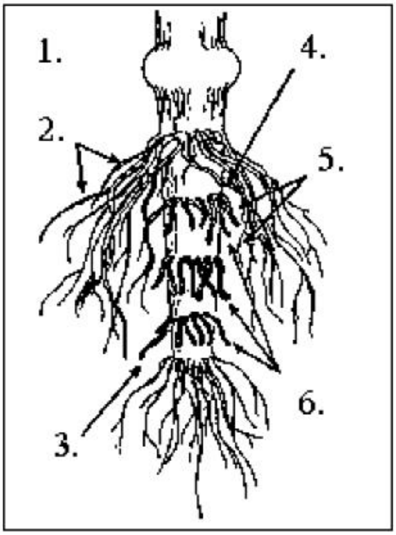
Western Corn Rootworm (WCR) *Diabrotica virgifera* sp. *virgifera* Le Conte (Col.,Chrysomelidae), is economically important Europeanmaize pest, native to America (Tollefson, 2007). It is an oligophagous pest, firstlyfound in Serbia (Europe) near the Belgrade airport, in the early '90 (Bača, 1993). After the Serbian findings, this pest spread to almost every maize field in Europe, causing serious damages on plants and reducing yield (Hummel *et al*., 2008). The WCR can spreadup to 100 km per year (Baufeld and Enzian, 2001). The pest has one generation per year (Bača, 1993) and severely damages roots and above-ground parts of maize (James *et al*., 2005; Ciobanu *et al*., 2009). Damages caused by WCR larvae feeding on the root are more serious than the once caused byadults, that feed on young leaves until the appearance of maize silk (Wesseler and Fall, 2010). Due tolarval damages ofthe root system, waterand mineral nutrientsuptake by maize plants is impeded (Chiang, 1973; Kahler *et al*., 1985). WCR larvae cause plant lodging after feeding on the nodal and lateral roots (Gavlovski *et al*.,1992) and also leadto yield losses (Tollefson, 2007). The appearance of a symptom called "goose neck" in the field indicates the presence of WCR (Wesseler and Fall, 2010). Well-developed root system, plant logging and the amount of secondary rootsare the indicators of maize tolerance to WCR (Gray *et al*., 1998). The robust root system represents a measure of high tolerance of maize to WCR roots injury that also occurs in the form of decreased lodging and increased root system size (Riedell and Evenson, 1993). Damages of WCR larvae are highly depended on environmental conditions, soil moisture, the type of soil andthe larval abundance in soil (Spike and Tollefson, 1989; Ciobanu, 2009).

## MATERIAL AND METHODS

The field experiment was carried out in municipality of Bečej located in province of Vojvodina in the Northern Serbia, during 2014 and 2015. In 2014, the experiment lasted from 2nd June until the 19th September. In 2015, it was performed from May 30$^{th}$ to September 10$^{th}$, with Serbian cultivar NS-640. The field chosen for the experiment represents a filed with the low natural WCR infestation. During the experiment, 96 maize plants were selected, labelled and arranged into pairs. The plants were in two rows with a space of 1 m, between the labelled plants. In each pair, one plant was artificially infested in the root zone withmL of WCR eggs in 0. 125% agar suspension (D plants). One mL of suspension contains 136 WCR eggs. The other plant from the pair was the control plant (C). In the root zone of C plant, the same amount of distilled water (4 mL) was injected.

In the both years, the experiment in the field was regularly inspected, once a week. During each observation, the presence of "goose neck" symptoms was recorded, and the number of plants damaged by the most important stem boring and leaf feeding insects (*Ostrinia nubilalis*, *Helicoverpa armigera*, *H. zeae*, aphids, mites, cicadas) was counted.

During the last field inspection on September 19th, 2014 and September 10th 2015, the damages of maize roots, caused by WCR larvae were evaluated. The root inspection was conducted in the following way: all marked plants were dug out, and the soil was removed from roots and after, the roots were rinsed. After the




Root rating scale (Ostlie and Notzel, 1987)

1 - No feeding damage
2 - Visible feeding scars present
3 - At least one root chewed to within 1. 1/2 inches of plant
4 - One entire node of roots destroyed
5 - Two nodes destroyed
6 - Three or more nodes destroyed

preparation, root damage was ranked from 1 to 6, according to scale by Ostlie and Notzel (1987).

Picture 1. Root damage scale (Ostlie and Notzel, 1987)

The differences between damages on D and C plants, based on the rate were analyzed using non-parametric Mann-Whitney test (Z).

## RESULTS AND DISCUSSION

The results in 2014 indicate that, based on the injury rate more, severe root damages were recorded onD plants, compared to the control (C)(Figure 1). From the total number of 48 D plants, only six (12. 5%), were with healthy root systems (rate 1). With visible rootdamages (rate 2) were two D plants or 4. 2 %. The most of damaged were 14 plants out of 48 D (37. 5%), rated as damage level 3 (at least one root chewed to within 3. 8 cm (1½ inches) of the plant). With one entire node destroyed (rate 4), ten plants were recorded, or 20. 8%. Eight plants (16. 7%) were rated as level 5 (with two nodes destroyed) and only seven D plants (14. 6%) had the highest root damages (rate 6).

On the other hand, from the total of 48 C plants, 46 plants (95. 8%) were with the healthy root system and only two (4. 2%) with two nodes destroyed, rate 5 (Figure 1).

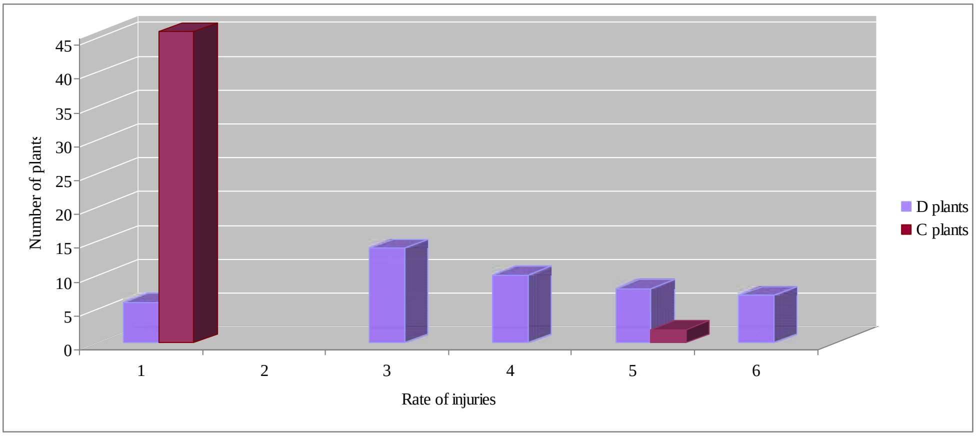



Figure 1. The level of root damages on D and C plants according to traditional scale (Ostlie and Notzel 1987) in 2014

In 2015, the number of D plants damaged by *H. armigera* was eleven and seven C plants, while the *O. nub*ilalis damages were registered on only one C plant. The damages from adult WCR were recorded on nine D plants and only on one C plant.
The obtained results in 2015 (Figure 2) were completely different compared to 2014. From a total of 48 C plants, 25 i. e. 52. 1% were with healthy root systems (rate 1). Visible damages causes by larvae (rate 2) were registered on three C plants (6. 25%). Rate 3 (with at least one root chewed to within 3. 8 cm (1½ inches)) were on nine plants or 18. 75%. Only one plant (2. 1%) was with one entire node destroyed, rate 4. Eight plants or 16. 7% were rated as the level of damage 5, and only two C plants (4. 2%) were with three or more nodes destroyed (rate 6).
The most of the infested D plants, 18 specimens (37. 5%) were with the highest root damages (rate 6). From the total number of infested plants, 11 plants (22. 9%) were with one entire node destroyed (rate 4). Seven plants (14. 6%) were with at least one root chewed to within 3. 8 cm (1½ inches) of the plant (rate 3). With visible damages caused by larvae (rate 2) wereeight plants or 16. 7%. Only fourD plants (8. 3%) from 48 plants were with healthy root system (rate 1). D plants with two nodes destroyed, rate five were not recorded in the experimental field (Figure 2).
The difference between the level of root damages on D and C plants was highly significant during the last observation (Z=4. 85**, p<0. 01).

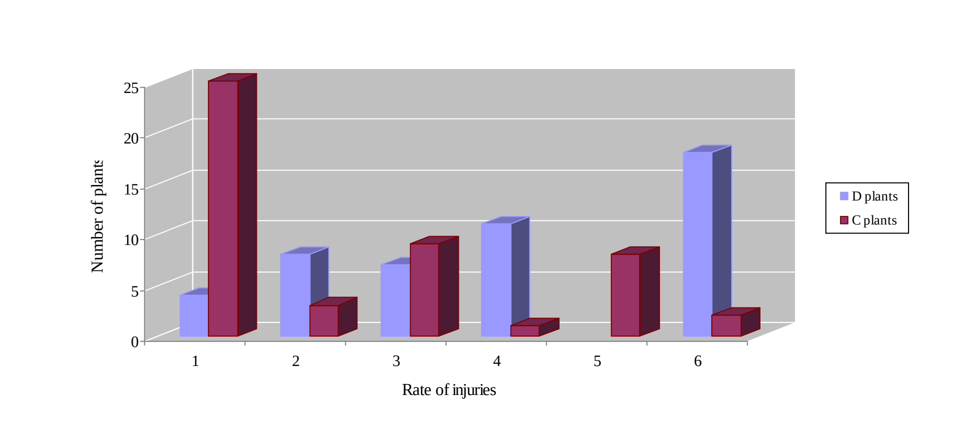



Figure 2. The level of root damages on D and C plants according to traditional scale (Ostlie and Notzel 1987) in 2015

During 2014 and 2015, WCR infestation caused damages on D plants, withthe different rate of root injury, 85% and 95. 7% respectively. These results show the higher level of damages on D plants in 2015 by10. 7%. From the total of 48 C plants in 2014 and 2015, the presence of WCR larvae caused different root injuries, 4. 2% and 47. 9% respectively. Larval presence in soil can cause different root damages as a consequence of different climatic condition or soil structure (Ciobanu, 2009). These results point to the higher level of damaged roots in 2015 on C plants (43. 7%).

In the field weekly observed the influence of WCR presence on appearance and damages of stem borers and leaf feeders. In 2014, the number of damaged D plants by *H. armigera* was 12, and of C was eight, while the damages from *O. nubilalis* were recorded on five D and four C plants. In 2015, the number of D plants damaged by *H. armigera* was11 and seven C plants, while the *O. nub*ilalis damages were registered on only one C plant. The damages from adult WCR were recorded on nine D plants and only on one C plant. It represents first parallel monitoring of presence stem borers, and leaf feeders in the WCR infested field.

During 2014 and 2015, the percent of C plants with healthy root system was 95. 8% and 52% respectively. These results show that the number of plants with no root injuries was by 43. 8% higher in 2014. Small larval mobility, different climatic conditions (vegetation period in 2015 was arid with a high number of tropic days) can be one of the reasons for the higher WCR population and increased damages on maize roots(Spike and Tollefson, 1989; Bača, 1998 Ciobanu, 2009).

According to the literature data, larval mobility is less than 50 cm (Bača, 1998), and these results also indicate that there is no rule of movement WCR larvae in the soil. The level of damages caused by the presence of WCR larvae in maize monoculture can increase the percent of lodged plants from 3% to 15% (Čamprag *et al*., 1997) and yield lossescaused by the lodging of plants, up to 75% (Bača *et al*., 1998). In their researches, Spike and Tollefson (1989) also point out that larval

presence in maize field leads to a decrease in yield. The same authors (1989) indicate that larvae causemore severe root injuries then adults on maize silk. Monoculture in maize field represents one of the main reasons for the increase in WCR population and contributes to bigger plant damages and root injuries (Sivcev *et al*., 2009; Chiang *et al*., 1969). The maize is a plant with a high ability to recover, and maize root tolerance is associated with its capability to grow new roots after larval injury (Gray *et al*., 1998).
In further research, the yield and the damages on maize plants, caused by larvae and adults of WCR will be registered.

## ACKNOWLEDGEMENT

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