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THE WESTERN CORN ROOTWORM (*Diabrotica virgifera virgifera* Le Conte) POPULATION IS INCREASING IN THE SOUTHEAST OF ROMANIA

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Abstract

The western corn rootworm (Diabrotica virgifera virgifera Le Conte) was first detected in Romania in 1996 the western part of the country. Since then, the insects have spread to the east. This paper presents the results of this pest population monitoring in southeast Romania at the National Agricultural Research and Development Institute, Fundulea, Călărași County, maize field. The first detection of this pest in the pheromone traps at NARDI Fundulea was in 2017. This study has presented the results of western corn rootworm fly monitoring at NARDI Fundulea between 2020 and 2024. It has used pheromone traps, KLPfero+ type, from Csalomon®. The highest population of this pest was recorded in 2020, with a total number of 2192 captures, followed by 2023 (1645 captures), 2022 (1521 captures), and 2021 (1020 captures). In 2020, the flight peak was in the first 20 days of July, while in 2021, it was in the first 20 days of August. In 2023, the flight peak was in the last 10 days of July, while in 2024, it was in the last 20 days of July.

Key words*: maize, pest, rootworm, high pressure.*

INTRODUCTION

Western corn rootworm (WCR) *Diabrotica virgifera virgifera* (Le Conte) is the most dangerous pest of the maize crops in North America (Miller et al., 2005; Gray et al., 2009; Gassmann et al., 2012; Manole, 2017; Bažok et al., 2021). Larva is the most harmful stage of this pest, damaging the root system of the maize plants (Spike & Tollefson, 1991; Levine **&** Oloumi-Sadeghi, 1996; Bărbulescu, 2000; Urías-López et al., 2001; Clark **&** Hibbard, 2004; Toepfer et al., 2008). The same authors mentioned that WCR third instar larvae produced higher damage at maize roots. During the feeding process, WCR larvae produced wounds at the plant roots and can cut off secondary and main roots (Kahler et al., 1985; Sutter et al., 1990; Urías-López et al., 2000; Wesseler & Fall, 2010; Furlan et al., 2022). If maize stability is affected, plants can fall on the ground after higher winds or storms (Meissle et al., 2009; Bazok et al., 2021; Amarghioalei et al., 2022). Attacked plants can partially recover, having the stems as a swan's neck (Antonie & Spânu, 2010; Florian et al., 2013; Tanasković et al., 2017). This is the most typical symptom of the WCR larva attack (Bărbulescu, 2000; Toepfer & Kuhlmann, 2006; Roșca & Istrate, 2009; Manole, 2017; Meinke et al., 2021). Damages produced by WCR in the United States exceed 2 billion dollars per year (Wechsler & Smith, 2018; Darlington et al., 2022). Early reports reference damages exceeding 1 billion dollars (Metcalf, 1986; Dun et al., 2010; Wesseler & Fall, 2010). The research made by WCR biology concluded that the maize monoculture favoured this pest (Bărbulescu, 2000; Gray et al., 2009; Sivčev et al., 2012; Manole, 2017; Bažok et al., 2021). New findings suggested that some larvae can appear over two years (Spence et al., 2009; Meinke et al., 2009). In that case, the system maize-soybean, practiced widely in the US Corn Belt, is ineffective for preventing WCR attack (Bažok et al., 2021; Darlington et al., 2022). Chemical control was the most common method used by the farmers to protect maize plants against WCR (Sutter et al., 1990; Van Rozen et Ester, 2010; Inđić et al., 2014; Meinke et al., 2021; Amarghioalei et al., 2025). Seeds treatment was used on a large scale in North

America and Europe (Bărbulescu, 2000; Wesseler & Fall, 2010; Ferracini et al., 2021). GMO maize is used on a large scale in the USA and Canada (Meissle et al., 2009; Deitloff et al., 2016; Bazok et al., 2021; Darlington et al., 2022). However, in the last two decades, there have been many references from the literature concerning WCR resistance to *Cry* toxins from maize GMO crops (Spencer et al., 2009; Cullen et al., 2013; Jakka et al., 2016; Gassmann et al., 2012; Paddock et al., 2021). At the same time, there are many references concerning WCR resistance to insecticides from different chemical classes (Miller et al., 2009; Souza et al., 2019; Meinke et al., 2021). The increase in the WCR populations and the resistance to insecticides and GMO maize can be a serious challenge for farmers in North America. In Europe, WCR is a relatively new pest, and was detected for the first time in former Yugoslavia, in a maize field near Belgrade airport in 1992 (Sivčev et al., 2002). In 1995, this pest was detected in Hungary and Croatia, in 1996 in Bosnia-Herzegovina, in 1998 in Italy (Venezia), in 2000 in Bulgaria, Slovakia, Albania, and in 2002 in France, near Paris (Manole, 2017; Bazok et al., 2021). From the first detection, in 1992, the WCR area in Europe extended, on average, by 40 km each year, ranging from 1 to 80 km/year, depending on weather conditions and crop structure (Kiss et al., 2005). Some studies revealed that in Europe, multiple WCR introductions were made from the North American continent (Ciosi et al., 2008; Bermond et al., 2012). Highest pest densities were registered in the south-east and the centre of Europe (Meinke et al., 2009; Sivčev et al., 2012; Furlan et al., 2022). In Romania, WCR was first detected in 1996, at Nădlac, in the Arad County, situated in the western part of this country, at 300 m from the border with Hungary (Bărbulescu, 2000). Since its first detection, WCR spread to the east of Romania. In the first decade of the 2000s, this pest was already present in the western half of this country (Antonie & Spânu, 2010; Grozea, 2010). The same authors mentioned that the insects expand to eastern areas from Romania at a slower speed because of the Carpathian Mountains chain. More recent data confirm faster WCR spreading to Romanian eastern and south-eastern areas, in Ilfov, Dâmbovița, Teleorman, Ialomița and Constanța Counties, where maize is cultivated on large areas (Manole et al., 2017). In 2015, WCR was reported for the first time in the Central Moldavia area from eastern Romania (Trotuș et al., 2020). Recent data from the same location reveal high WCR adults' density captured in the traps placed in the maize crops (Amarghioalei et al., 2024). This data reveals that Romania could increase the danger of high WCR pest pressure in the maize crops in the future. In this paper, the authors present the results of the WCR flight monitoring, with pheromone traps in the south-east of Romania.

MATERIALS AND METHODS

The flight of WCR adults was monitored at the experimental field of the Agrotechnics Laboratory, from National Agricultural Research and Development Institute Fundulea, Călărași County, Romania (latitude: 44°46' N; longitude: 26°32' E; alt.: 68 m a.s.l.), between 2020 and 2024. At this experimental site, soil type is chernozem with medium texture, humus content of 2.8-3.2%, pH of 6.4-6.8, nitrogen content of 0,17-0,18 %, potassium content of 135-170 ppm, and phosphorus content of 10-25 ppm. In 2020 and 2021, this study used the F423 maize hybrid; in 2022 and 2023, it used the Iezer hybrid; and in 2024, it used the Felix hybrid. These hybrids were created at NARDI Fundulea and were from the FAO 401-500 group (Horhocea et al., 2019; 2024). In the experimental field, soil works, fertilisation, and herbicide applications followed the technology for maize crops.

- In 2020, the maize was sown on 14 April, plants emerged on 28 April, and the harvest was on 17 September.
- In 2021, the maize was sown on 7 May, plants emerged on 15 May, and the harvest was on 5 October.
- In 2022, the maize was sown on 3 May, plants emerged on 10 May, and the harvest was on 4 October.
- In 2023, the maize was sown on May 5, plants emerged on May 12, and the harvest was on 22 September.
- In 2024, the maize was sown on 14 May, plants emerged on 21 May, and the harvest was on 31 October.

For **monitoring the seasonal fly patterns of the WCR adults in the maize field**, four traps, KLPfero+ type with sexual pheromone (4-Methoxyphenyl)-2-propenal, from Csalomon®, a commercial brand of the Plant Protection Institute, Budapest, Hungary, have been placed. The traps were placed on a square 100 m apart from each other. The minimum distance between traps and crop margins was 20 m. The traps were placed in the maize field from the beginning of May until the first 10 days of October (Figures 1 and 2).

Figure 1. Pheromonal KLPfero+ trap used for monitoring seasonal fly of the WCR at NARDI Fundulea (29.05.2020)

The height of the traps was adjusted according to the maize vegetation stage. The pheromones were replaced after 4 weeks during the summer months and 6 weeks in May, September, and October. The traps were assessed two times per week.

Figure 2. Pheromonal KLPfero+ trap used for monitoring seasonal fly of the WCR at NARDI Fundulea (10.07.2023)

Meteorological data were collected from the Davies automatic weather station in the NARDI Fundulea experimental field, located 1500 m from the experimental site. During this study, the station monitored daily air temperature and rainfall from April to September. Table 1 presents the 50-year average monthly temperature and total rainfall from the field site.

Table 1. Temperatures and rainfalls multiyear average at NARDI Fundulea field site from April to September

Month	Temperature 50 years average (°C)	Rainfalls 50 years average (mm)
April	11.3	45.1
May	17.0	62.5
June	20.8	74.9
July	22.7	71.1
August	22.3	49.7
September	17.5	48.5

The data presented in Figure 3 shows that in the field site, located at NARDI Fundulea, in the southeast of Romania, the average temperature registered in the summer months was higher than the 50-year average in all five years of this study. Temperatures recorded in April exceed the multiyear average in 2020, 2022, and 2024, while temperatures recorded in May were closer to the averages compared with other months.

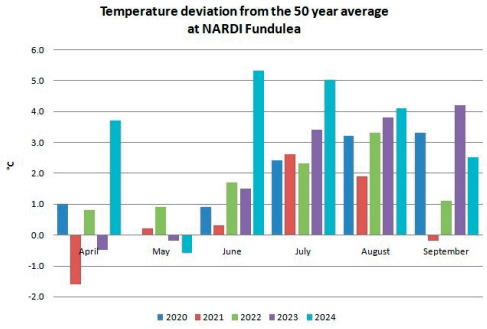

Figure 3. Temperature deviation from the 50-year average at NARDI Fundulea from 2020 to 2024

The highest deviation from the average was in June 2024 (+5.3°C), followed by July 2024 (+5.0°C) and August 2024 (+4.1°C). This year was the warmest in Romania since the meteorological recordings started (Ionita & Nagavciuc, 2025). The lowest deviation from the average was recorded in April 2021 (-1.6°C).

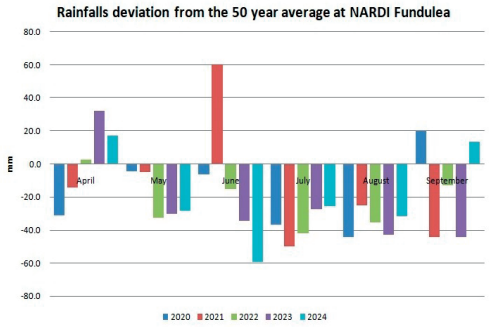

Figure 4. Rainfall deviation from the 50-year average at NARDI Fundulea from 2020 to 2024

Data from Figure 4 reveal that in the field site, located at NARDI Fundulea in southeastern Romania, during the study period (2020-2024), except for June 2021, in all summer months, it has registered lower rainfalls than the 50-year averages. The highest negative deviation from the averages was recorded in July 2024 (-59.3 mm), while the highest positive deviation was in June 2021 (+60.1 mm). Overall weather conditions during this study, in the summer months, were higher temperatures than the averages, and lower rainfall amounts compared with the averages.

Monitoring results are presented as absolute and mean values of the adults WCR captured per trap, the average adults WCR capture per trap in 10 days, and the total number of WCR captured during one maize growing season. During this study, the seasonal fly pattern of this pest at NARDI Fundulea was presented graphically on Microsoft Excel charts.

RESULTS AND DISCUSSIONS

WCR was first detected at NARDI Fundulea, in Călărași County, southeast Romania, on 13 July 2017 (Figure 5), during monitoring by the Research and Development Institute for Plant Protection (RDIPP Bucharest) entomologists in collaboration with NARDI Fundulea. The monitoring used the same traps and pheromones as in this study. The previous year, no WCR adults were observed in the traps (Manole, 2017). No WCR flight was monitored at NARDI Fundulea in 2018 and 2019. Monitoring started again in 2020. Figure 6 shows the total WCR adults captured in the traps during one monitoring season.

Figure 5. WCR adults (*Diabrotica virgifera virgifera*) were first detected at NARDI Fundulea on 13 July 2017

In this study, the highest number of WCR adults captured in the traps was in 2020 (2192 captures), followed by 2023 (1645 captures) and 2022 (1521 captures).

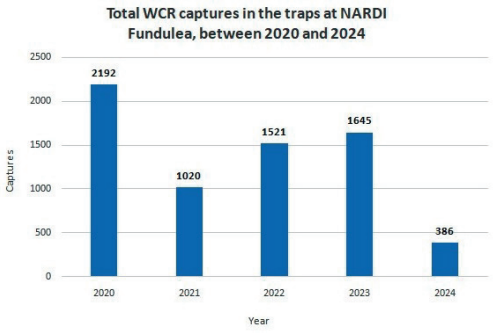

Figure 6. The total WCR captured in the traps at NARDI Fundulea during the maize growing season, between 2020 and 2024

The lowest number of WCR adults captured in the traps during the maize growing season was in 2024. A possible explanation for these high differences between the WCR population in 2024 and the previous year from this study is the unfavorable weather conditions for larva development this year. Drought and high temperature can diminish the number of WCR larvae in the first two instars (Bărbulescu, 2000; Manole, 2017). The same authors mentioned that WCR larva emergence is from the end of May to the end of July, and their life span is, on average, three weeks. Jackson and Elliot (1988) mentioned that at higher temperatures in the soil, where WCR larvae are found, up to 33°C, no larvae in the second instar will survive. Meteorological data

recorded at the field site reveal that in June 2024, the air temperature was the highest deviation from the 50-year average (Figure 3). Between 17 and 19 June 2024, the maximum air temperature exceeded 35°C; on 20 June, it exceeded 38°C (Figure 7).

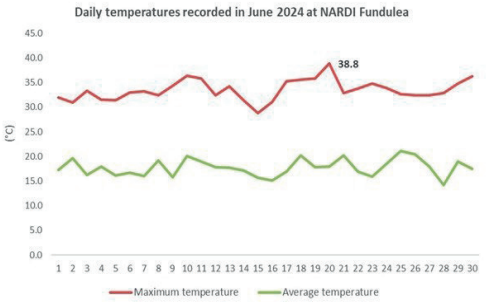

Figure 7. Daily temperatures recorded in June 2024 at NARDI Fundulea

This early heatwave recorded in June 2024 in the southeast of Romania could affect WCR larva development in the soil and decrease the WCR population at the field site where this study was conducted.

Table 2. The WCR flight pattern at NARDI Fundulea, southeastern Romania, from 2020 to 2024

Month	Decade	2020	2021	2022	2023	2024
May	I	0*	0	0	0	0
	II	0	0	0	0	0
	III	0	0	0	0	0
June	I	0	0	0	0	0
	II	0	0	0	0	0
	III	1.75	0	3.25	0	0
July	I	296.75	1.25	10.75	70.50	15.00
	II	141.00	11.50	92.50	127.50	40.25
	III	80.50	43.50	141.75	117.00	26.75
August	I	14.25	68.50	102.25	70.25	20.25
	II	6.25	95.00	25.00	17.50	2.75
	III	4.25	28.50	4.50	8.00	0
September	I	1.00	5.75	0.50	0.50	0
	II	0	0.75	0	0	0
	III	0	0.25	0	0	0
October	I	0	0	0	0	0
	II	0	0	0	0	0
	III	0	0	0	0	0

*the average number of WCR adults/trap in 10 days

Table 2 shows the data concerning the seasonal flight pattern of the WCR adults at the maize field site, NARDI Fundulea, southeastern Romania, between 2020 and 2024.

In 2020, the first WCR adults were captured in the traps on 29 June, followed by a sudden growth of trapped insects. The maximum flight peak was in the first 10 days of July (296.75 captures/trap), when in some traps, there were more than 300 trapped WCR adults (Figure 8), followed by the next 10 days of this month (141.00 captures/trap). In August, fewer WCRs were trapped, while the last captured adults were in the last 10 days of September.

Figure 8. High number of WCR adults trapped in the first 10 days of July 2020, at NARDI Fundulea

In 2021, the first WCR adults were captured on 5 July. Compared with the previous year, the flight curve showed smooth growth. The maximum flight peak was recorded in the first 20 days of August with an average of 68.50 captures/trap in the first 10 days, and 95 adults/trap in the next 10 days, which was the flight peak. The number of trapped WCR adults decreased gradually in the last 10 days of August. However, in the first 10 days of September, it recorded the highest captures from the entire study period. The last WCR adult was trapped on 29 September.

In 2022, the first WCR adults were captured on 27 June. It recorded a few trapped insects in the first 10 days of July. This contrasts with the situation from 2020 when the maximum flight peak was in the first 10 days of July. The flight peak was in the last 10 days of July (141.75 captures/trap). A high trapped WCR adult was in the first 10 days of August. The last insect captured in the trap was on 6 September.

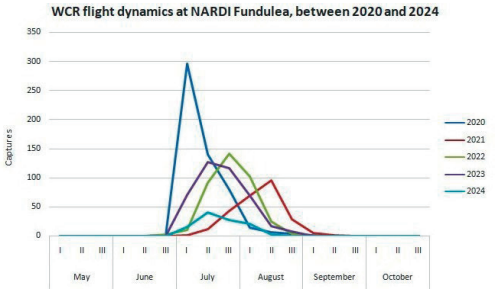

Figure 9. WCR flight dynamics at NARDI Fundulea, between 2020 and 2024

In 2023, the first WCR adults were captured in the traps on 3 July. The maximum flight peak was in the second 10 days of July (127.50 captures/trap), followed by the last 10 days of this month (117.00 captures/trap). In the first 10 days of August, it registered 70.25 captures/trap, followed by a decrease in the flight peak. The last captured WCR adult was on 9 September.

In 2024, the first WCR adults were captured in the traps on 2 July. The data from the first capture was like that of the previous year and 2021. However, the evolution of WCR this year was atypical compared with the previous four years of this study. The flight peak was in the second 10 days of July, but WCR captures in the traps from the maize field site were lower than in the previous years (Figure 9).

After peaking in 2020, the WCR population at the NARDI Fundulea maize field site fluctuated in the following three years and decreased in 2024. More studies are necessary to elucidate the influence of climate change on WCR populations' dynamics.

CONCLUSIONS

This study reveals new information about the evolution of the WCR adults (*Diabrotica virgifera virgifera*) in recent years at NARDI Fundulea, Călărași County, in southeastern Romania, three years after their first detection in 2017.

In 2020, the maize field site at NARDI Fundulea registered the highest number of WCR adults captured in the traps, followed by 2023 and 2022. In 2024, the number of trapped WCR adults was very low. A possible explanation for this is drought and an early heat wave registered in June that can destroy the WCR larvae in the soil.

In 2020, 2022, 2023, and 2024, the WCR flight peak was registered in July, while in 2021, it was in August.

This study demonstrates that there can be a high WCR pressure in the maize fields in southeast Romania, because of which this pest can threaten maize production in the future.

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