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NEW DATA CONCERNING THE EVOLUTION OF THE EUROPEAN SUNFLOWER MOTH (*Homoeosoma nebulellum* Den. & Schiff.) IN SUNFLOWER CROPS IN THE SOUTH-EAST OF ROMANIA

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Abstract

The European sunflower moth [Homoeosoma nebulellum (Den. & Schiff.)] is a pest that can sometimes significantly damage sunflower crops in the south and southeast of Romania. Many studies reveal that the pest attack on cultivated crops, including sunflower, can be higher because of global warming. Also, global warming can have consequences in increasing the pest generation's number in one year or the area in northern latitudes. This study has monitored the fly of the European sunflower moth in sunflower crops from NARDI Fundulea, Călărași County, southeast of Romania, between 2019 and 2021. It has used Delta traps with atraNeb pheromones, produced at "Raluca Ripan" Institute for Research in Chemistry, Cluj-Napoca, Romania. The evolution of the European sunflower moth in sunflower crops at NARDI Fundulea differed in this three-year study. The monitoring of this pest in sunflower crops reveals that first captures were recorded at the beginning of May in 2019 and 2021 and the end of April in 2020. In climatic conditions of the year 2019, at NARDI Fundulea, it has recorded three fly peeks of this pest on 28 May, 26 July, and 19 Augusr. In 2020 the maximum fly peek was registered on 9 June, and a secondary lower peek on 2 September. Similar to 2019, in 2021, it registered three fly peeks on 11 June, 19 August, and 13 September. Higher captures recorded at NARDI Fundulea in September 2019 and 2021 weren't reported in Romanian literature before and are possible consequences of global warming, but further studies are necessary to elucidate these aspects.

***Key words**: sunflower, moth, fly peek, monitoring.*

INTRODUCTION

Sunflower is one of the most important crops for Romanian agriculture. In the last seven years, the area cultivated with this crop was higher than 1 million hectares (except in 2017), while average production ranged from 1765 to 3041 kg/ha (Romanian Statistical Yearbook, 2021; MADR, 2022). According to the Eurostat database, Romania occupies first place in EU27 with the highest area cultivated with sunflower (Eurostat, 2022). However, according to the same agricultural statistics, only in some years did Romania have the highest sunflower production in Union Europe. The main reason for lower sunflower yield in Romania, compared with other countries in the EU, is draught, broomrape, weeds, diseases or pests (Bărbulescu et al., 2001a,b; Petcu et al., 2001; Popov, 2002; Ciucă et al., 2004; Popov et al., 2007; Saucă et al., 2010, 2018; Petcu et Păcureanu, 2011; Anton et al., 2015; Rîșnoveanu et al., 2016; Csép, 2018; Hussain et al., 2018; Trotuș et al., 2019; Škorić et al., 2021). In Romania, sunflower crop, in first vegetation stages (from plants emergence BBCH 10 until four leaves stage, BBCH 14) is attacked from several pests, that can produce high yield losses such as maize leaf weevil (*Tanymecus dilaticollis*), darkling beetle (*Opatrum sabulosum*) wireworms (*Agriotes* spp.) or turnip moth (*Agrotis segetum*) (Popov et Bărbulescu, 2007; Georgescu et al., 2018; Trașcă et al., 2019; Trașcă et al., 2021). However, before and after the flowering stage, sunflower can be attacked by several pests, such as black bean aphid (*Aphis fabae*), leaf-curling plum aphid (*Brachycaudus helichrysi*), European corn borer (*Ostrinia nubilalis*), corn earworm (*Helicoverpa armigera*) and birds (Čamprag et al., 1981; Linz et Hanzel, 1997; Van Denberg et al., 1997; Reddy et al., 2004; Trotuș et Buburuz, 2015; Truzi et al., 2017; Demenko et al., 2019; Sausse, 2021). In Romania and neighboring countries, European sunflower moth [*Homoeosoma nebulellum* (Den. & Schiff.)] is a common pest of sunflower (*Helianthus annuus*) and creeping thistle (*Cirsium arvense*) (Boguleanu et al., 1980; Lemetayer et al., 1993; Szaruká et al., 1996; Perju, 1999; Roșca et Istrate, 2009). The same authors mentioned that this pest presents two generations per year (G1 May-June; G2 Jully-April). The first generation develops on wild hosts from the Asteraceae family, such as creeping thistle (*Cirsium arvense*), while the second generation develops on sunflower crop. Recent studies reveal that, in the North-East of Hungary, the European sunflower moth presents three generations per year (Szabó et al., 2009). A possible explication for this is the increase in the temperatures resulting from global warming (Olesen et al., 2011; Bebber et al., 2014; Choudhary et al., 2019). European sunflower moth larva developed in sunflower caladium, consuming inflorescences and seeds (Perju, 1999; Szabó et al., 2007; Roșca et Istrate, 2009). In Azerbaijan, average sunflower yield losses from this pest attack arrive at 460 kg/ha (Ismayilzade et al., 2015). According to Szabó et al. (2009), in the Nyírség region (north-east of Hungary), a traditional sunflower variety (Kisvárdai) is attacked by European sunflower moth larva because the shells don't contain a phytomelan layer. In Romania, the larva produced more severe damage in the third stage in old sunflower varieties (Roșca and Istrate, 2009). In the last decades, the National Agricultural Research and Development Institute (NARDI) Fundulea has created sunflower hybrids with shells with a phytomelan layer (Vrânceanu et Stoenescu, 1978, 1988; Păcureanu et al., 2007; Csép, 2018). As a result, European sunflower moth larva can't drill the seeds, and the damages are lower. However, in the last decade, the Ecological Agriculture system has used older sunflower varieties with shells not resistant to larva attacks (Brumă, 2021). Also, in our country, it wasn't recent research concerning European sunflower moth biology in the conditions of the climate changes. This study aims to monitor seasonal fly patterns of this pest in the sunflower crop, using pheromone traps in the climatic conditions in southeast Romania.

MATERIALS AND METHODS

The flight of the European sunflower moth was monitored at the experimental field of the Plant Protection Collective from Agrotechnics Laboratory, 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 2019 and 2021. 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. Also, the multiyear average temperature registered at NARDI Fundulea in the last 60 years is 11,0 °C, while the average rainfall amount registered in the last 60 years is 571 mm. In 2019 and 2020, this study used the Performer sunflower hybrid, while in 2021, it used the FD15E27 hybrid. Both were created at NARDI Fundulea and have the same vegetation period (Păcureanu et al., 2007; 2019).

- In 2019, the sunflower was sowed on 25 April, plants emerged on 4 May, and the harvest was on 2 September.
- In 2020, the sunflower was sowed on 9 April, plants emerged on 21 April, and the harvest was on 16 September.
- In 2021 the sunflower was sowed on 28 April, plants emerged on 7 May, and the harvest was on 24 September.

For monitoring the seasonal fly patterns of the European sunflower moths in the sunflower field, it has placed three Delta traps with atraNeb sexual pheromones, produced at "Raluca Ripan" Institute for Research in Chemistry, Cluj Napoca, Romania (Vasian et al., 2018). The traps were placed at 50 m one from each other, according to a methodology developed by Ghizdavu et Roșca (1984) cited by Roșca et al. (1986). At the same time, the minimum distance between traps and sunflower crop margins was 15-20 m. The traps were placed in the sunflower field from the beginning of April until the first ten days of October (Figure 1). The height of the traps depends on sunflower crop vegetation stages. The pheromones were replaced after 4-6 weeks. At each reading, for moths counting, adhesive plates from Delta traps were photographed with Panasonic TZ200 compact camera with Leica Vario-Elmar lens (1;3.3-6.4/8.8-132 ASPH).

Figure 1. Pheromonal (AtraNeb) Delta trap used for monitoring seasonal fly of the European sunflower moth at NARDI Fundulea (7.05.2020)

The images with captures from Delta traps were downloaded to the computer, then the images were magnified, and the moths were counted (Figure 2). The purpose of using a photo camera is to increase the accuracy of insect identification and counting. Monitoring results are presented as absolute and mean values of the male moth's capture per trap and average moth's capture per month. During this study, the seasonal fly patterns of the European sunflower moth at NARDI Fundulea are presented graphically on Microsoft Excel charts.

Figure 2. Captures of the European sunflower moth, photographed with Panasonic TZ200 photocamera, at NARDI Fundulea (7.05.2020)

Meteorological data were collected from an automatic weather station from NARDI Fundulea experimental field, located 100 m from the experimental site. It monitors daily air temperature and rainfalls from April to October during the monitoring period.

RESULTS AND DISCUSSIONS

At the experimental site, located at NARDI Fundulea, in Călărași County (south-east of Romania), the average year temperature was higher than expected values for this region (Figure 3). The highest deviation of the year temperature from the last 60 years' averages it has registered in 2021 (T = 13.45°C). In all three years of this study (2019-2021), the temperature was higher than usual, with a positive deviation from 1.18 to 2.45°C.

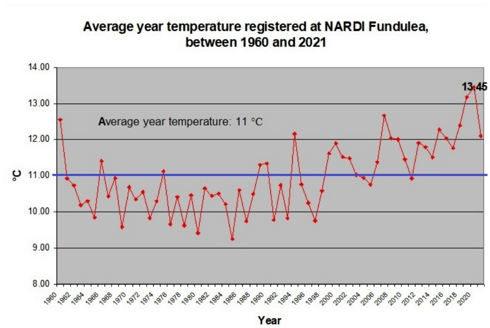

Figure 3. Average year temperature registered at NARDI Fundulea, between 1960 and 2021

Regarding rainfalls amount registered at NARDI Fundulea, data from the meteorological station reveal a high variability from one year to another (Figure 4).

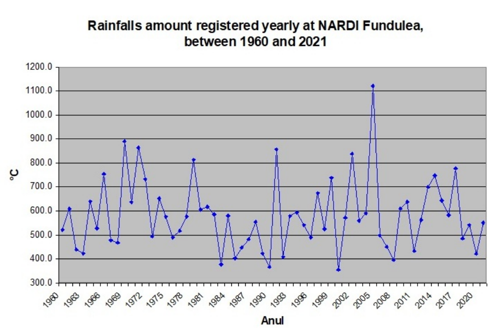

Figure 4. Rainfalls amount registered yearly at NARDI Fundulea, between 1960 and 2021

However, during this study, the rainfall amount registered at the experimental site was lower than 60 years average, with a negative deviation ranging from 19.6 (in 2019) to 149 mm (in 2020).

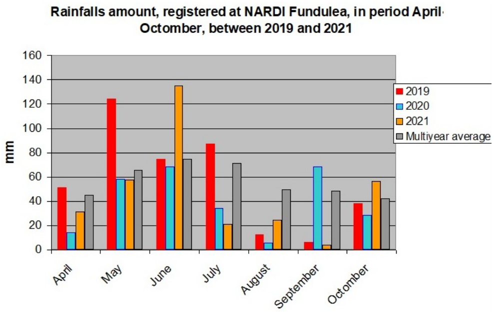

Figure 5. Rainfalls amount registered at NARDI Fundulea in April-Octomber, between 2019 and 2021

During this monitoring, between 2019 and 2021, rainfalls were higher than average in May 2019, with a positive deviation of 59 mm, and in June 2021, with a positive variation of 60.1 mm (Figure 5). In 2020, rainfall registered from April to September was bellowing the average, except for September. It is essential to mention that in September 2020, more than 80 % of the rainfalls amount were registered on only one day (4 September).

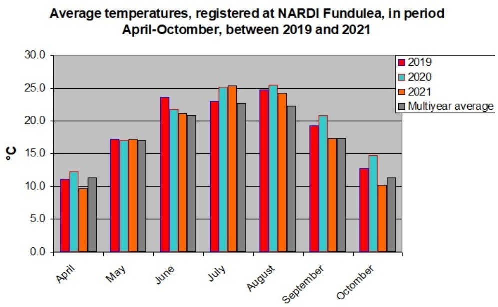

Figure 6. Average temperatures registered at NARDI Fundulea in April-October, between 2019 and 2021

Temperatures registered during this study were over multiyear average in the summer months in all three years (Figure 6). In April, the average temperature was higher than average in 2022, slightly lower than average in 2019, and lower than the multiyear average in 2021, with a negative deviation of 1.6°C. In May, the average temperature was close to average in all three years, while in September and October, temperatures were higher than the multi-year average in 2019 and 2020. Weather conditions during this study were warmest than average, although, in some spring or autumn months, temperatures were lower than average. At the same time, rainfalls amount have a positive deviation from the average in some months, but in many months were quieter than usual. Many types of research prove that in Central and Eastern Europe, including Romania, temperatures increased and rainfalls decreased (Olesen et al., 2011; Bebber et al., 2014; Choudhary et al., 2019). The same authors mentioned that it could register higher rainfalls amount for short periods (one day or a few hours).

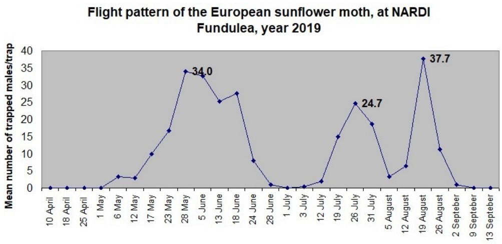

Figure 7. Flight pattern of the European sunflower moth, at NARDI Fundulea, year 2019

The captures from pheromone traps show the variability of the fly of the European sunflower moth during the three years of this study. In 2019, the first captures were recorded on 6 May. Then it has a constant increase in the capture number until 28 May, when it has registered the first fly peek, with an average of 34.0 captures/trap (Figure 7).

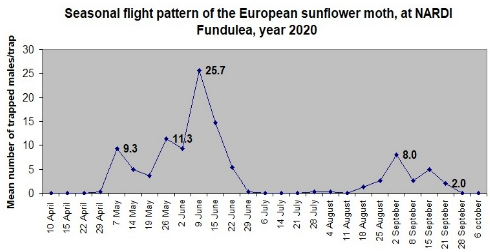

Figure 8. Flight pattern of the European sunflower moth, at NARDI Fundulea, year 2020

Between 3 July and 2 September, it has registered continuous flight of European sunflower moth, with two peeks on 26 July (24.7 captures/trap) and 19 August (37.7 captures/trap). From all three flight peeks registered in 2019 at NARDI Fundulea, the highest fly peek was in the second part of August.

In 2020, the first capture was recorded on 29 April, with a fly peek on 9 June (25.7 captures/trap). This year it has recorded two fly peeks, compared with the previous year (Figure 8). Also, the second fly peek in autumn was lower (8.0 captures/trap). The last catch in the pheromone traps was recorded on 21 September. A possible explication for the lower number of captures from the second generation is because of draught from the summer.

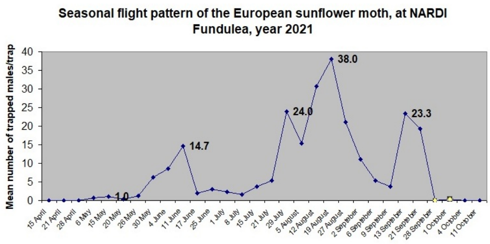

Figure 9. Flight pattern of the European sunflower moth, at NARDI Fundulea, year 2021

Perju (1999) mentioned that in the years with low rainfalls during the summer, many larvae from the first generation remain in diapauses in the soil and then continue with winter hibernation. As a result, the insect number from the second generation is lower. In 2020, the rainfall amount recorded in July and August was below the multi-year average, while June was slightly lower.

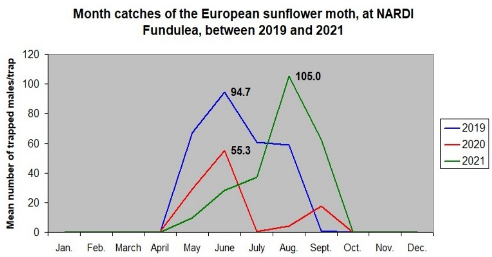

Figure 10. Moth catches of the European sunflower moth, at NARDI Fundulea, between 2019 and 2021

In 2021, the first capture was recorded on 6 May. Like 2019, it was three fly peeks of the European sunflower months (Figure 9). The highest fly peek registered on 19 August (38.0 captures/trap). The last capture was recorded on 1 October, although it was a continuous flight from 6 May!

Summarising the data from this study, it can conclude that in 2019 and 2020, most of the captures from the pheromone traps were recorded in May and June, while in 2021, the majority of the captures were recorded in August and September (Figures 10 and 11).

The result of this study is quite similar to those obtained by Szabó et al. (2009) in northeast Hungary. The author mentioned that the second and the third generation of the European sunflower moths could not be clearly distinguished due to seasonal flight patterns. A similar situation was observed during monitoring this pest, at NARDI Fundulea, in 2019 and 2021. At the same time, the case reported by Szabó et al. (2009) in Hungary in 2007 was similar to those recorded at NARDI Fundulea in 2020. However, in the Romanian literature, it wasn't referenced to the higher-flying peek of the European sunflower moth, recorded in August or the first half of September.

Figure 11. High captures of the European sunflower moth, at NARDI Fundulea, 6 Seotember, 2021

Olesen et al. (2011) mentioned that global warming has consequences in increasing the generation numbers of the insect species in one year (including sunflower pests). As a result, pest pressure on crops increases.

Regard as atraNeb pheromone, the results of this study reveal high selectivity of this compound, used in the monitoring of the European sunflower moth. The pheromone traps have recorded accidental captures of the green lacewing adults (*Chrysoperla carnea*), especially in June, and corn earworm (*Helicoverpa armigera*), in July and August. However, the differences between these accidental captures and monitored sunflower pests are apparent. Further studies are necessary for the main areas cultivated with sunflower in Romania, using an automatic monitoring system, to assess better the impact of global warming concerning the evolution of the main pest species of this crop. Also is necessary to see the possibility of the increasing pressure of the European sunflower moth on sunflower crops and the behaviour of the new sunflower hybrids to this pest in global warming conditions.

CONCLUSIONS

This study reveals new information about the evolution of the European sunflower moth (*Homoeosoma nebulellum*) in climatic conditions in southeast Romania.

In 2019 and 2021, it was three fly peeks of this pest, while in 2020, it had two fly peeks, although the second fly peek was reduced.

In 2019 and 2021, it has observed more captures in August and September.

AtraNeb pheromone is very selective for European sunflower moths

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