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# POPULATION DYNAMICS OF MAIZE PEST SPECIES IN AN AGROECOSYSTEM WITH AGROFORESTRY SHELTERBELTS IN THE TRANSYLVANIAN PLATEAU

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**Abstract:** This study evaluated the abundance and flight dynamics of major maize pests within an agroecosystem protected by agroforestry shelterbelts in the Transylvanian Plateau. Monitoring was carried out from May to September 2024 at the Cean–Bolduț farm (Cluj County), using species-specific pheromone traps for *Ostrinia nubilalis*, *Agrotis segetum*, *Helicoverpa armigera* and *Diabrotica virgifera virgifera*. Climatic parameters were recorded to assess their influence on pest activity. *D. v. virgifera* was the species with the highest abundance, recording 674 captured adults, an average of 61.3 adults per trap, and the peak in flight activity in late July. It was also the only species showing a statistically significant correlation with minimum temperature ($r = 0.48$, $p < 0.05$). The other species exhibited moderate to low abundances and showed no significant associations with climatic variables. These findings highlight *D. v. virgifera* as the primary pest threat in agroecosystems with shelterbelts and emphasize the need for targeted monitoring.

**Keywords:** *agroforestry shelterbelts, maize pests, pheromone monitoring, abundance.*

## INTRODUCTION

Agriculture is facing significant challenges stemming from the increasing pressure exerted by crop pests, climate change, and the need to maintain the sustainability of agricultural ecosystems (Skendžic et al., 2021; Majeed et al., 2023; Saleem et al., 2025).

In this context, the integration of protective forest shelterbelts represents an increasingly used strategy for optimizing the microclimate, enhancing biodiversity, and reducing the negative impact of pests on crop yields (Malschi et al., 2018a; Grădilă et al., 2018; Vălean et al., 2025). Given global warming, the intensification of aridization, and current climate changes, agricultural systems that include forest shelterbelts have proven to be effective ecotechnologies, contributing significantly to erosion control and to the promotion of sustainable agriculture in the Transylvanian Plateau (Malschi et al., 2018b). The implementation of agroforestry shelterbelts in agroecosystems supports the restoration of degraded land through natural bioremediation processes and, at the same time, helps reduce insecticide pollution by enhancing the ecosystem's capacity to naturally regulate pest populations (Samal et al., 2024; Enescu et al., 2025).

Harmful insects represent one of the main constraints affecting maize (*Zea mays* L.) yield, especially in the context of climate change, which influences both insect biology and

population dynamics. In Europe, and particularly in Romania, maize crops are affected by several key pests, among which *Ostrinia nubilalis* Hübner, *Agrotis segetum* Den. & Schiff., *Helicoverpa armigera* Hübner and *Diabrotica virgifera virgifera* LeConte are considered of economic importance (Pintilie et al., 2022; Bujora et al., 2023; Toader et al., 2024; Georgescu et al., 2025). Without integrated management strategies, these species lead to yield losses (Chiriloaie-Palade et al., 2024). The purpose of pest control in crop production is to keep pest populations and damage at economically sustainable levels (Kanwal et al., 2022).

Monitoring pest populations is therefore essential for understanding their fluctuations and identifying peak adult activity as well as establishing the basis for effective integrated pest management (de Oliveira et al., 2024). Pheromone traps (Hong et al., 2021) serve as a reliable tool for this purpose, offering accurate data on adult flight period (Ivezić et al., 2023), population abundance (Petrovskii et al., 2012), and potential outbreak risks.

Considering these aspects, the present research focuses on assessing the abundance and population dynamics of several pest species in maize crops, under the conditions of an agroecosystem protected by forest shelterbelts.

## MATERIALS AND METHODS

### Study Area

The study was conducted at the Cean-Bolduț farm, located in Cluj County (46°35'58"N; 23°56'26"E), within the hilly region of the Transylvanian Plateau (Figure 1). The farm is managed under an anti-erosion agricultural system with protective agroforestry shelterbelts. The area is characterized by marked pedoclimatic variability associated with its fragmented relief.

According to the Office for Soil and Agrochemical Studies (OSPA) Cluj report (2022), the dominant soils are chernozemic and argic-illuvial, with medium to high fertility, favorable for field crops including maize. The regional climate is temperate continental, with a mean annual temperature of 8-9°C and annual precipitation ranging from 500 to 650 mm, unevenly distributed across the year (Malschi, 2007; OSAS Cluj, 2022).

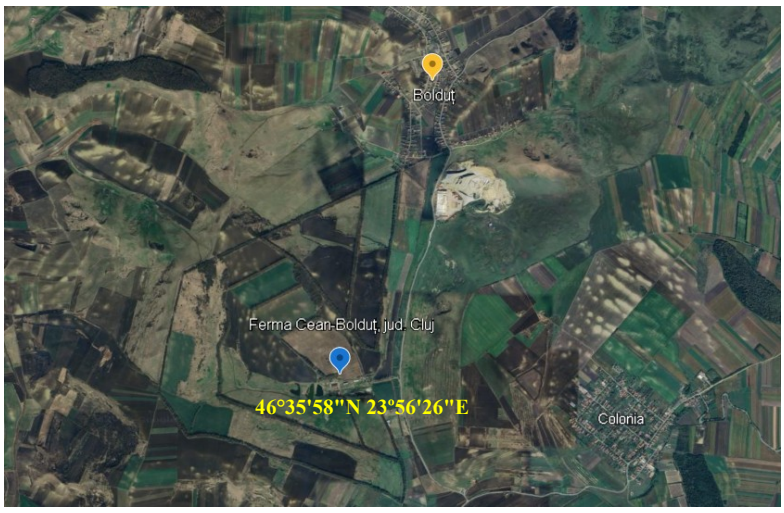


Figure 1. Location of the Cean-Bolduț Farm (Cluj)
(https://www.google.com/maps/)

The agroforestry shelterbelts surrounding the plots consist of mixed rows of more than 36 tree and shrub species. The marginal rows are composed of fruit tree species and fruit shrubs*:* *Cerasus avium*, *Malus sylvestris*, *Pyrus piraster*, *Prunus spinosa*, *Crataegus pentagyna*, *Rosa canina*, *Vaccinium vitis-idaea*, *Corylus avellana*, *Ligustrum vulgare*, *Staphylea pinnata*, *Sambucus nigra,* etc. The inner rows consist of forest tree species: *Quercus robur*, *Ulmus* sp., *Robinia pseudoacacia*, *Acer platanoides*, *A. pseudoplatanus*, *Fraxinus excelsior*, *Tilia cordata* and *Salix alba*.

**Pest Monitoring**

Monitoring was conducted from May to September 2024 and consisted of weekly observations of the abundance and population dynamics of four pest species in maize crops. Three lepidopteran, *Ostrinia nubilalis*, *Agrotis segetum*, *Helicoverpa armigera*, and one coleopteran pests, *Diabrotica virgifera virgifera,* were monitored using species-specific sex pheromone traps. Trap types included Delta traps for *O. nubilalis*, tetratraps for *A. segetum*, funnel traps for *H. armigera* and roof-type traps for *D. v. virgifera* (Figure 2). All traps were placed at 1 - 1.5 m above ground level. Pheromone lures were replaced every 4 weeks, and adhesive plates every 2 weeks.

**Figure 2.** Pheromone traps used for monitoring the pest species (A) Delta trap, (B) Tetratrap, (C) Funnel trap, (D) Roof-type trap (original)

**Statistical Analysis**

Data were analyzed using the Duncan multiple range test (Polifact software) to determine differences in mean captures among species. Correlation analysis between pest abundance and climatic variables was performed using PAST version 4.03.

**RESULTS AND DISCUSSIONS**

During the monitoring period (May - September 2024), air temperature and relative humidity exhibited significant fluctuations, which directly influenced the activity of maize pest species within the agroecosystem with protective shelterbelts. Relative air humidity showed high values at the beginning of May, fluctuating between 60 and 80% thereafter, with a peak in early June and a gradual decrease toward the end of the monitoring period. The maximum air temperature increased progressively from May, reaching values above 35°C in July - August. Minimum temperatures followed a similar pattern, generally ranging between 10 and 20°C, with higher values recorded in the second half of July (Figure 3).

These climatic conditions, marked by elevated temperatures and moderate fluctuations in humidity, provided a favorable environment for increased flight activity in some of the monitored species, particularly in July and August.

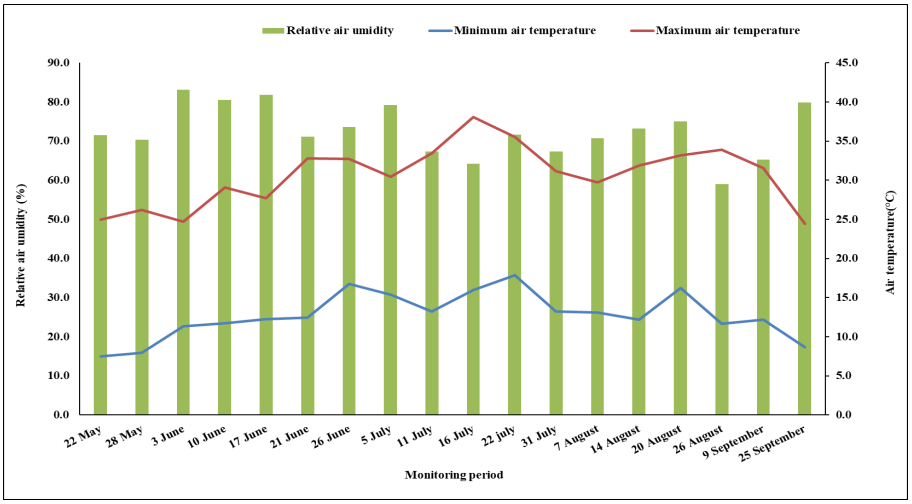


**Figure 3.** Air temperature and relative air humidity during the monitoring period of maize pest species, Cean-Bolduț farm, 2024

*D. v. virgifera* registered the highest number of adults captured among the four species monitored (674 adults), considerably exceeding the overall mean number of total captures at the Cean-Bolduț farm (Figure 4). The markedly higher abundance of *D. v. virgifera* indicates that this species represents the main pest risk in the agroecosystem with forest shelterbelts, suggesting the need for specific monitoring and control measures.

The species *O. nubilalis* and *A. segetum* showed moderate abundances, with 116 and 88 adults captured, respectively, remaining well below the levels recorded for *D. v. virgifera*, yet still contributing to the overall complexity of the pest entomofauna within the agroecosystem. In contrast, *H. armigera* exhibited the lowest activity, with only 20 adults captured.

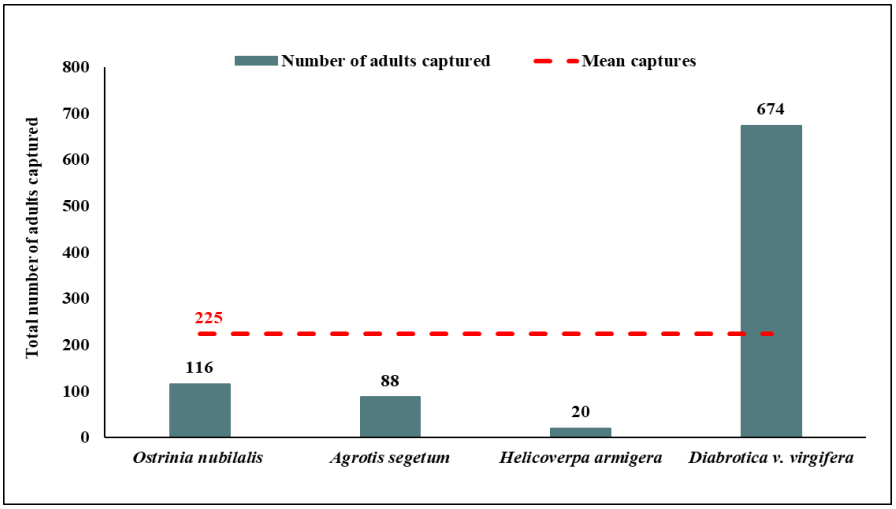


**Figure 4.** Abundance of pest species in maize crops, Cean-Bolduț farm, 2024

The data presented in Table 1 reveal notable differences in the flight dynamics of the four pest species monitored in the maize crop within the agroecosystem with protective shelterbelts. According to the Duncan test values, *D. v. virgifera* recorded the highest flight activity, with a mean of 61.3 adults per trap, a value statistically different from the other three species ($P < 0.05$). This species registered peak flight activity in July and August, with maximum values of 189 adults on July 31 and 159 adults on July 22.

In contrast, *O. nubilalis* exhibited moderate flight activity, with a mean of 6.4 adults and a peak in June (28 adults). *A. segetum* showed a low flight dynamic, with a mean capture of 4.9 adults and a relatively constant flight activity throughout the monitoring period. *H. armigera* recorded the lowest abundance (1.1 adults), with sporadic flight activity.

These results show that *D. v. virgifera* is the dominant species in terms of flight dynamics within the agroecosystem with forest shelterbelts, requiring specific monitoring and control measures, while the other species had a reduced impact in 2024.

**Table 1.** Flight dynamics of maize pest species (Duncan test), Cean-Bolduț farm, 2024

| Date | *Helicoverpa armigera* | *Agrotis segetum* | *Ostrinia nubilalis* | *Diabrotica v. virgifera* |
|---|---|---|---|---|
| 22 May | 7 | 16 | 0 | - |
| 28 May | 4 | 10 | 0 | - |
| 3 June | 0 | 3 | 1 | - |
| 10 June | 0 | 1 | 5 | - |
| 17 June | 0 | 2 | 8 | - |
| 21 June | 0 | 0 | 28 | - |
| 26 iunie | 0 | 1 | 22 | - |
| 5 June | 2 | 14 | 27 | 11 |
| 11 July | 0 | 18 | 9 | 10 |
| 16 July | 0 | 16 | 12 | 129 |
| 22 July | 1 | 0 | 0 | 159 |
| 31 July | 0 | 1 | 1 | 189 |
| 7 August | 0 | 1 | 0 | 108 |
| 14 August | 0 | 0 | 2 | 27 |
| 20 August | 0 | 2 | 1 | 29 |
| 26 August | 4 | 3 | 0 | 8 |
| 9 September | 2 | 0 | 0 | 0 |
| 25 September | 0 | 0 | 0 | 4 |
| Mean | 1.1 a | 4.9 a | 6.4 a | 61.3 b |

Note: Means followed by the same letter within a column do not differ significantly from each other ($P < 0.05$), according to the Duncan test.

Among all the species analyzed, only *D. v. virgifera* showed a statistically significant correlation with minimum air temperature ($r = 0.48$, $p < 0.05$), suggesting that this species increases its flight activity as nighttime temperatures rise (Table 2).

**Table 2.** Correlation coefficients (r) between the abundance of maize pest species and climatic conditions

| Pest species | Min°C | Max°C | UR (%) |
|---|---|---|---|
| *Helicoverpa armigera* | $-0.51^{0}$ | $-0.29^{ns}$ | $-0.32^{ns}$ |
| *Agrotis segetum* | $-0.11^{ns}$ | $0.05^{ns}$ | $-0.21^{ns}$ |
| *Ostrinia nubilalis* | $0.39^{ns}$ | $0.29^{ns}$ | $0.14^{ns}$ |
| *Diabrotica virgifera virgifera* | 0.48* | $0.35^{ns}$ | $-0.19^{ns}$ |

The other three species, *H. armigera*, *A. segetum*, and *O. nubilalis*, did not show statistically significant correlations with any of the climatic parameters analyzed. The low and non-significant values suggested that the activity of these species was less dependent on temperature and humidity fluctuations under the conditions of the agroecosystem with protective shelterbelts (Table 2).

## CONCLUSIONS

A varied abundance among the pest species monitored in 2024 was recorded in the agroecosystem with forest shelterbelts at the Cean-Bolduț farm.

According to the Duncan test values, *D. v. virgifera* exhibited a significantly higher abundance than the other monitored species.

Temperature was the main factor influencing the population dynamics of maize pest species, with relative air humidity having a lesser impact.

The monitoring results highlight the need for targeted management strategies, with a particular focus on *D. v. virgifera*, as it represents the most significant threat to maize crops in the agroecosystem with protective shelterbelts at the Cean-Bolduț farm.

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