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RESEARCH REGARDING THE *Ostrinia nubilalis* Hbn. (LEPIDOPTERA: CRAMBIDAE) ATTACK AT MAIZE CROPS UNDER THE CENTRAL OF MOLDOVA CONDITIONS, ROMANIA

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ABSTRACT

The *Ostrinia nubilalis* Hbn. larvae causes attacks and production losses by feeding with different parts of the plant (stem, cobs, inflorescence). The insect is spread throughout Romania, the frequency of attack is, on average, between 30.3% and 70%. The importance of *Ostrinia nubilalis* Hbn. attacks produced at maize led to the initiation of studies in 2017 at ARDS Secuieni with the purpose to establish the role of technological links in reducing the attack caused by insect larvae. The result obtained regarding the experimentation of five sowing epochs highlighted the high attack on larvae of maize sown in epochs IV and V in comparation with the optimal epoch. The attack produced by larvae at different genotype under the conditions of Central of Moldova, was between 28.59% (Turda 248) and 35.83% (Turda 165), compared with the average experience of 33.34%. Regarding the positioning of the attack on the plant, it is found that highest number of gallery were identified in the area under the cobs compared to the panicle area, where their number was much lower. The application of insecticides through treatments on vegetation reduced the attack of larvae ensuring the protection of maize plants, the variant treated with the active substance cyantraniliprol 200 g/l registered the lowest attack of 9.4%. In the variants treated with insecticides, the attack had values between 11.6% and 15.4% compared to the untreated variant, which registered an attack of 22.5%. In the period 2017-2020, under the conditions in Central Moldova, the sowing epoch and treatment with insecticides on vegetation significantly influenced the attack, and in terms of cultivated hybrid, the differences were insignificant.

Keywords: epoch, treatment, attack frequency, galleries length.

INTRODUCTION

The important role that maize plays in several segments of industry makes it one of the most cultivated species. Globally, in 2019 maize was cultivated on 197 million ha (FAOSTAT data, 2021), and in Romania on 2,678.5 thousand ha (MADR data, 2021). Its spread over large areas also attracts a series of pests that attack at different developmental phases, the attack being located on various parts of plant.

One of these dangerous pests is *Ostrinia nubilalis* Hbn., a species that occurs during the vegetation period of maize and causes production losses through the attack on the stem, cob or inflorescence (Trotuş et al., 2018).

It has been estimated that damage caused by larval infestations at maize exceeds $ 1 billion annually in yield losses and expenditures involving attack prevention and control (Siegfried and Hellmich, 2012).

In Asian countries, *Ostrinia furnicalis* is found a species related to *Ostrinia nubilalis*, which causes damage to corn crops in a similar way, with production losses ranging from 4% (Vietnam) to 18% (Pakistan), but in years with severe infestations can lead to the complete destruction of the crops (Gianessi, 2014).

In Europe, maize crops are affected, to varying degrees, by the attack produced by this insect which is very well adapted to the various climatic conditions of the continent.

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The proportion in which the maize crop is affected by the insect attack differs from one region to another. Of the total area of maize cultivation in France, 1-2 million ha are affected by larval attack, and in Germany the insect produces losses on areas between 300,000 and 500,000 thousand ha. In the Czech Republic, 80,000-90,000 ha of maize suffer from larval attacks, in Slovakia the larvae of the species attack about 50,000 thousand ha of maize, and 15,000 ha of maize from Portugal are affected by the insect attack (Brooks, 2009).

The species *Ostrinia nubilalis* Hbn. it is widespread throughout Romania, but the attack varies greatly from one region to another. Thus, in Central of Moldova, the frequency of attack is, on average, 30.3% (Trotuș et al., 2018), in the Transylvanian Plain, the level of attack has values of 58.1%, (Tărău et al., 2019), this being close to the one registered in the West of the country, which is 59% (Ștef et al., 2020). In Oltenia, the attack is between 22.4% and 40.7% (Drăghici, 2012), and in the south of the country, the attack produces by insect is between 50% and 70% (Popov and Roșca, 2007).

The species is widely described in the literature. The insect has a generation in the northern parts of the country, and in the southern part of the country a complete and a partial generation (Roșca et al., 2011). The insect is distinguished by the attack produced on maize plants, in the favorable years for the evolution of the species the highest damage is caused by the larva. The larvae are found on the panicle, leaves, stem or cobs, where they perforate and create galleries of different lengths. The galleries in the stem weaken its resistance to extreme environmental conditions and break, and at cobs, it depreciates the quality of the grains, favoring the installation of pathogens (Trotuş et al., 2021)

Prevention and reduction of *Ostrinia nubilalis* Hbn. attack it is achieved by applying the cultural hygiene measures and the technological links in the cultivation technology. Chopping plant residues that remain in the field after harvesting maize is one of the measures that diminishes the population of mature larvae. Its take shelter inside the stems to survive the winter, where they find favorable conditions to stand the winter. Soil work (plowing and ploughed stubble field) reduces the density of larvae of *Ostrinia nubilalis* Hbn. (Trotuş et al., 2021).

The sowing epoch is an important element of maize technology. Sowing in the optimal range leads to avoiding the overlap of vulnerable phenophases of maize culture with the appearance and attack produced by insect larvae. An important aspect for females of *Ostrinia nubilali*s Hbn. in the laying of the egg is given by the size of the plants and the time of development. If eggs laying occurs early when the maize is growing vegetatively, females choose higher-sized crops. If eggs laying occurs later, the timing of plant development is a priority, with the female turning to plants that are in the pollination phenophase (Brindley et al., 1975). The results obtained by Obopile et al. (2012) show that maize sown later has a deeper degree of larval attack, with longer galleries.

The maize genotype has different tolerance to the attack produced by the larvae of *Ostrinia nubilalis* Hbn. and depends on the climatic conditions at the time of eggs laying and the appearance of larvae, the phenophase in which the crop is infested and the numerical pressure of the population in that region. Its behavior in the attack produced by larvae has been studied both by Romanian and foreign researchers, being an objective for identifying attack-tolerant forms of maize (Pereverzev, 2005; Bereś and Gorski, 2012; Georgescu et al., 2013).

Concerns in reducing attack by applying chemical measures in maize crops have been investigated internationally and nationally.

Dondo et al. (2020) studied the effectiveness of applying insecticide treatments in order to reduce the attack produced by the two generations of *Ostrinia nubilalis* Hbn. in Serbia. The applied insecticides decreased the attack, registering the maximum value of 81.62% for the treatment variants, compared to the untreated variant, which showed 91.72%.

Under the conditions in southern Romania, the active substance cyantraniliprol provided superior protection to corn plants, with low attack, few larvae/plant and small galleries compared to the untreated variant (Georgescu et al., 2019), and the results obtained Tărău et al. (2019) showed that the active substances indoxacarb and deltamethrin had efficacy values of 90% and 85%, respectively. Experiments conducted by Ștef et al. (2020) in maize crops to reduce the attack produced by *Ostinia nubilalis* Hbn., showed that the active substance alpha-cypermethrin at a dose of 0.6 l/ha recorded the highest efficacy, 72.88%, followed then the active substances acetamiprid + lambda-cyhalothrin at a dose of 0.15 l/ha with an efficacy of 69.49% andalpha-cypermethrin at a dose of 0.15 l/ha with efficacy values of 59.32%.

Given the importance of the attacks produced by the species *Ostrinia nubilalis* Hbn. in maize crops in Central of Moldova and beyond, at ARDS Secuieni, since 2017, studies have been carried out on establishing the role of technological links (sowing epoch, cultivated hybrid and application of an insecticide on vegetation) in reducing the attack produced by the larvae of *Ostrinia nubilalis* Hbn. Thus, in this paper are presented results obtained in the period 2017-2020 regarding these aspects.

MATERIAL AND METHODS

In order to achieve our proposed objectives, in the period 2017-2020, a series of experiences were placed in the experimental field of the Agricultural Research and Development Station Secuieni located at the geographical coordinates of 26°5' east longitude and 46°5' north latitude. The experiments were placed in the field according to the randomized block method, with three replications and included the following experimental factors: sowing epoch, cultivated hybrid and application of chemical insecticides through treatments on vegetation. One plot was consisted of four rows of maize sown with a total area of 28 m^2 (10 x 2.8 m).

The influence of the sowing epochs

The crop was sown in five epochs that corresponded to the three decades of April and the first two decades of May. The cultivation technology was the specific one for the conditions in Center of Moldova. The hybrid used was Turda Star.

Sowing epoch:

- Epoch I - extra-early sowing (first decade of April);
- Epoch II - early sowing (second decade of April);
- Epoch III - optimal sowing (the third decade of April) for the conditions in the Center of Moldova;
- Epoch IV - semi-late sowing (first decade of May);
- Epoch V - late sowing (second decade of May).

Influence of the cultivated hybrid

The purpose of this experiment was to establish the reaction of hybrids from various maturity groups to the attack produced by larvae. During this experiment, several maize hybrids sown in the optimal time for the conditions in Central Moldova were studied. The tested variants were represented by six Romanian maize genotypes from different precocity groups: Turda 165 (FAO 270), Turda 248 (FAO 300), Turda Star (FAO 370), Turda 344 (FAO 380), Turda 332 (FAO 380) and Olt (FAO 430).

Influence of chemical treatment

Five insecticides with active substances from the group of pyrethroids, anthranilamides and neonicotinoids were experimented with treatments applied on vegetation. (Table 1). The application of the treatment was carried out every year, in the first decade of July, using portable sprayers.

Table 1. Products used in vegetation

The insecticide used	Dose	Active Substances	Class
Untreated variant	-	-	-
Coragen	175 ml/ha	cyantraniliprol 200 g/l	anthranilamide
Decis mega 50 EW	75 ml/ha	deltamethrin 50 g/l	pyrethroid
Mavrik 2 F	200 ml/ha	tau-fluvalinate 240 g/l	pyrethroid
Mospilan 20 SG	100 g/ha	acetamiprid 200 g/kg	neonicotinoid
Fastac active	300 ml/ha	alpha-cypermethrin 50 g/l	pyrethroid

The experiments were located on a typical cambic chernozem type soil, with pH in water 6.29, humus content 2.3, nitrogen index 2.1, content in mobile P_2O_5 39 ppm and mobile K_2O 161 ppm.

The maize crop was established respecting the cultivation technology of this species in the conditions of Central Moldova (Trotuș et al., 2020) according with the experimental protocol.

At the end of the vegetation period, 25 plants/variant/repetition were harvested, which were sectioned to establish the following parameters of the attack: frequency of attacked plants, average number of holes/plant, average number of galleries/plant, average number of larvae/plant and the average length of the galleries.

Also, in order to have a clearer situation of the attack level and the damage that larvae cause to maize plants, the stem was divided into four zones, the attack being recorded as located under the cob, at the cob, above the cob and to panicle (in the area of the inflorescence).

Statistical analysis

The results obtained are presented as average values of the monitored parameters (frequency of attacked plants, average number of holes/plant, average number of galleries/plant, number of larvae/plant and length of galleries), the same procedure being applied for data regarding the positioning the attack on the plant. The data were calculated in Excel (Microsoft USA), and the results obtained were interpreted with the ANOVA program (analysis of variance).

The meteorological data were recorded from the weather station VANTAGE PRO 2, located in the experimental field, the station being automated with the recording and storage of data in the computer. In the climatic interpretation of the experimentation years, we used data on the average air temperature (°C) and the amount of precipitation (mm).

RESULTS AND DISCUSSION

The climatic conditions recorded in the 4 years of observations and determinations show the warming of the area and the decrease of the precipitation amount.

Figure 1 shows the evolution of temperatures recorded during the vegetation period of maize and which corresponds to the range of occurrence and evolution of the species *Ostrinia nubilalis* Hbn. In terms of temperature, the year 2017 was normal, the values of the average monthly temperature being close to the multiannual average, this year being favorable for the evolution of the insect. The rest of 2018, 2019 and 2020 recorded much higher average monthly temperatures than the multiannual average, being characterized by warm weather. The warming trend of the area has had a negative impact on the evolution of developmental stages, reducing the adult population and larval attack. The months of April, May, June and August in 2018 were warmer and recorded deviations of over +2°C compared to monthly multiannual average. The same situation was recorded in 2019 and 2020, when June and August were warmer with over 1.5°C compared to monthly multiannual average (Figure 1).

In terms of rainfall, from April to September it is found that this period was characterized as very dry (Figure 1). Analyzing the amounts of precipitation that fell in 2017 and 2018, it is found that it covered the need for water, the years being considered normal. Although the year 2018 was normal in terms of the amount of precipitation, their distribution was very uneven, April, May, August, September registering deviations from -32.1 mm to -42.3 mm. The most deficient months in precipitation during the maize vegetation period were May, June and August in 2019 with deviations between -29.2 mm and -39.8 mm, respectively April (-43.7 mm) and June (-45.3 mm) in 2020, the last two years being characterized as dry.

It is found that the period April-September of 2017 and 2018 was favorable for the appearance and development of the insect. The conditions from the same period in 2019 and 2020 negatively influenced the biological cycle of the species and the attack produced by larvae.

In the warm years in terms of temperatures and normal in terms of the amount of rainfall, the flight of adults is quite intense in maize crops (Trotuș et al., 2018). Thus, out of the four years analyzed, two years were favorable for the evolution of this species.

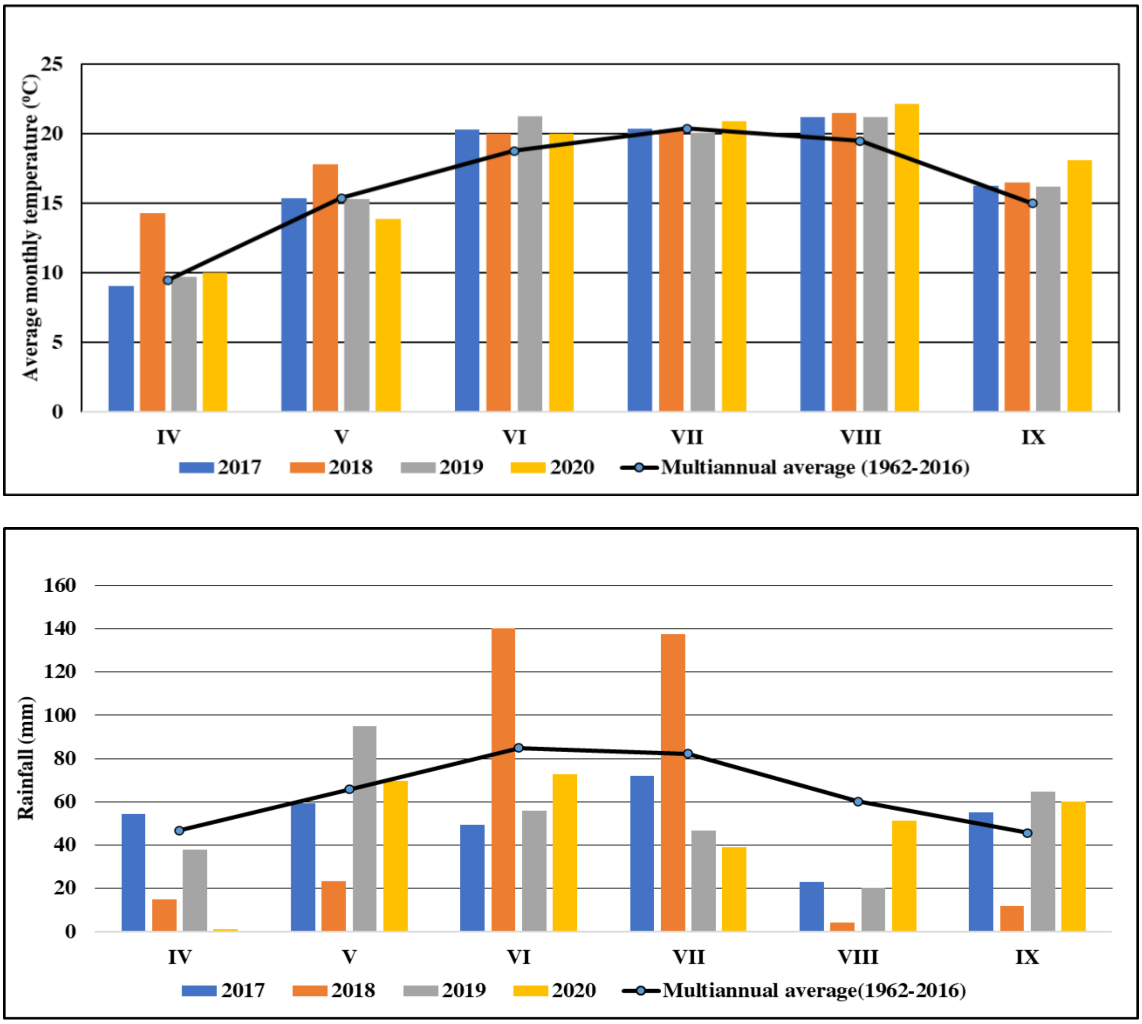

Figure 1. The climatic conditions recorded during the vegetation period of maize between 2017-2020, Secuieni-Neamț

The results obtained regarding the influence of the three factors on the reduction of the attack produced by larvae materialized as follows:

Sowing epoch

Analyzing the influence of the sowing epochs, it was found that the examined plants from the five epochs registered variations of the attack between 28.74% (IInd epoch), assured as negative very significant and 48.86% (Vth epoch) assured as very significant, compared with the control, the IIIrd epoch (32.72%) (Figure 2).

The average number of holes created by larvae to enter the stem was between 0.66 holes/plant as identified in the analyzed plants from the Ist epoch and 0.85 holes/plant recorded at the IInd epoch, the optimal epoch (IIIrd) had recorded 0.83 holes/plant (Figure 2).

The galleries created by the larvae inside the maize plants are another way to quantify the attack produced, the maize sown in the optimal epoch presented the lowest number of galleries, of 0.31 galleries/plant compared to the maize sown in epochs Ist and Vth which have registered the most numerous galleries, of 0.44 galleries/plant and of 0.48 galleries/plant (Figure 2).

The maize plants from the Vth epoch registered the highest number of larvae, of 0.41 larvae/plant, while the maize sown in the optimal epoch (the IIIrd) showed the lowest number of larvae, of 0.13 larvae/plant.

Regarding the average length of the gallery per plant, this parameter recorded close values between 6.13 cm (IInd epoch) and 8.48 cm (Vth epoch) which were statistically assured.

In the conditions of Central of Moldova it was observed the staggering of egg laying until the end of July, late sown maize being the one that offers much more favorable feeding conditions for larvae compared to early maize.

It is noted that there is no close link between the number of holes and the frequency of attacked plants, the attack focusing on fewer plants that had a larger number of holes as in the case of plants from the IInd epoch. Also, in the case of plants from Vth epoch, the larvae created fewer holes, but on a larger number of plants which led to higher frequency values.

In the Mediterranean area, Ordas et al. (2013) state that it is possible to reduce the effect of the attack by pests *Sesamia nonagrioides* Lefebvre and *Ostrinia nubilalis* Hübner, by varying the sowing epoch. Thus the most sensitive stages of the crop no longer coincide with the flight peak of the pest. The researchers found a relationship between insect damage and the number of days from flowering to infestation. Their recommendation is to sow as early as possible so that the tissues are as mature as possible when the larvae appear and attack.

From the obtained results it is highlighted that the choice of the optimal time to sow is closely related to the climatic conditions in spring and it is found that epoch plays a secondary role in the evolution of the insect attack. Average daily temperatures, air humidity, atmospheric drought, precipitation during the maximum flight of the species, from the laying of eggs, hatching of eggs, respectively the appearance and evolution of larvae are the factors that determine the lower or higher intensity of attack in maize crops.

Bărbulescu et al. (1982) specify that the attack is greatly reduced due to unfavorable conditions of atmospheric humidity recorded during the laying period and immediately after infestation. In an experiment with two sowing epochs (epoch I - third decade of April; epoch II - third decade of May), Bărbulescu and Sarca (1983) mention that there was a stronger attack in the whorl phase on the plants from epoch II, a fact also found in the maize crops sown in late epochs (IV and V) in the conditions of Central Moldova. Instead, at Ist epoch it was observed a more pronounced attack on cobs.

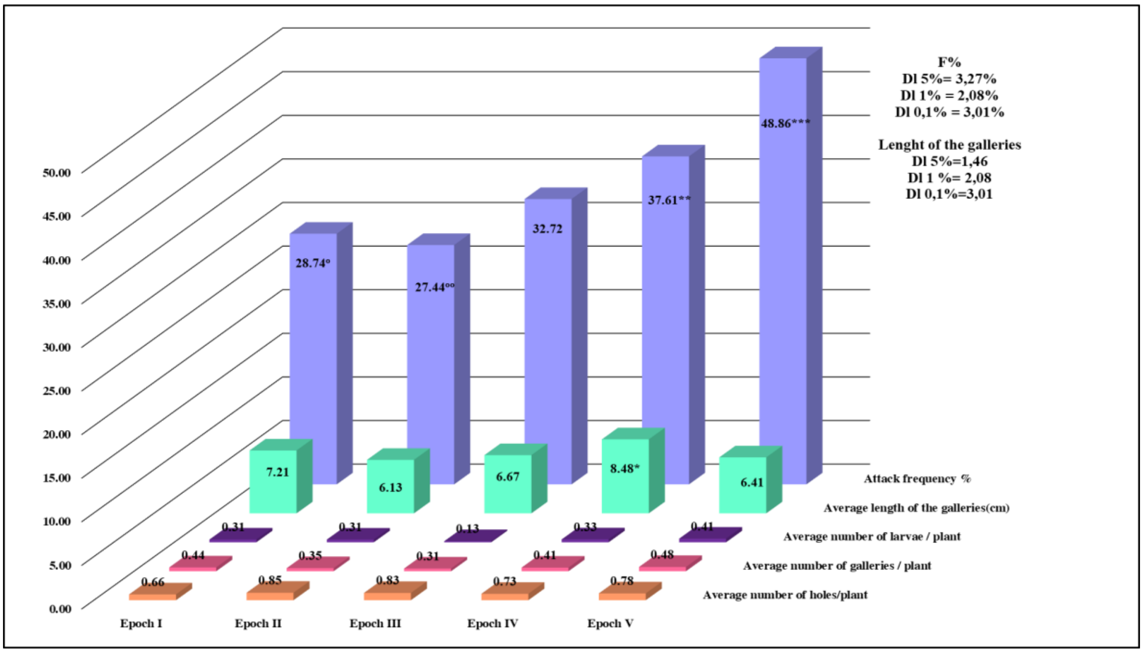

Figure 2. Evolution of the attack produced by the larvae of the species *Ostrinia nubilalis* Hbn. for maize sown in different epochs, average 2017-2020

On the plant, the attack produced by larvae under the cobs recorded the highest shares, of over 45%, in all five epochs experienced, followed by the area above the cob in the Ist and IIIrd epochs which showed galleries in percentage more than 30%, while in epochs IVth and Vth, the larvae perforated in a higher percentage, over 23% in the cob area (Figure 3).

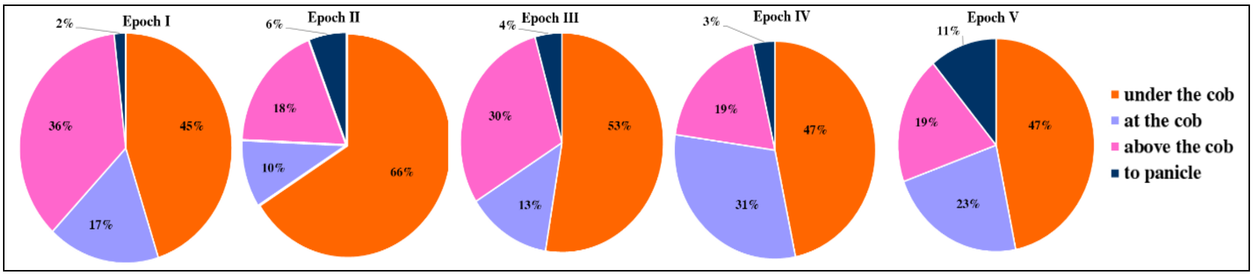

Figure 3. The share of galleries produced by larvae per plant in maize sown in different epochs, average 2017-2020

The longest galleries were recorded in a fairly high proportion, over 40% under cobs in all the plants analyzed in all the five epochs studied. The second most affected area, which showed galleries share with high values, of over 34%, was the one located above the cob in the Ist epoch and IInd epoch, while in the IVth and Vth epochs the longest galleries with a share of over 23% were identified in the cob area (Figure 4).

All parameters show the attack that larvae produce on corn plants. But the number of holes is quite uneven, and the number of larvae identified is variable because some do not survive until autumn, either perish or migrate to other plants. The number of galleries and their length clearly describe the intensity of the attack produced by the larva on the plant. The location of the galleries shows that the area where the attack is concentrated is located under the cobs, which later leads to the breaking of the plants. In fact, from the total length of the gallery it can be noticed that the highest weight was under the cobs, where the larvae weaken the integrity of the stem by consuming the marrow.

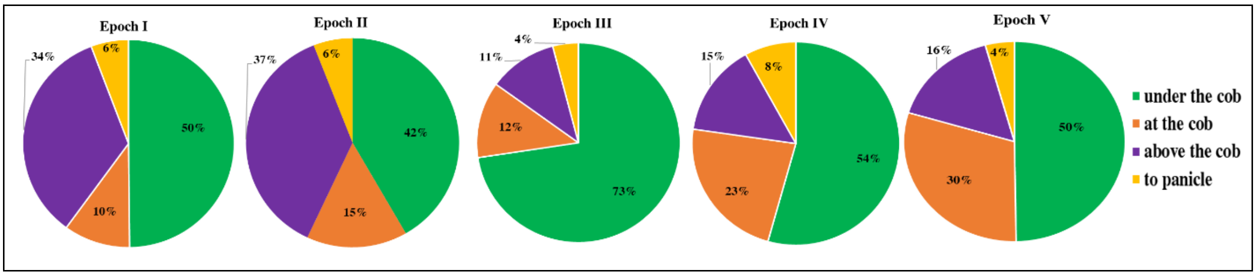

Figure 4. The share of the galleries length according to the location on the plant of the attack on the maize sown in different epochs, average 2017-2020

Genotype influence

The obtained results regarding the cultivated maize genotype indicate that experienced hybrids Turda 165, Turda 248, Turda Star, Turda 344, Turda 332 and Olt recorded frequencies of attack and infestation level that varied within very wide limits compared to the experience average. The attack was between 28.59% (Turda 248) and 35.83% (Turda 165) compared to the experience average, of 33.34% (Figure 5).

Regarding the average number of holes/plant, it was much reduced to the Turda 332 genotype (0.43 holes/plant), the values being negative significant compared to the experience average. The most numerous holes were registered at Turda Star, Turda 344 and Olt, which showed values higher than the experience average (0.62 holes/plant) and were statistically assured as significant.

The galleries identified in the analyzed plants were more numerous at Olt genotype compared to the average of the experiment and were assured as very significant, the rest of the hybrids recording values close to the number of galleries of the experience average (Figure 5).

The number of larvae/plant at harvest is a difficult parameter to interpret due to the staggering of eggs laying by the species in the conditions of Central of Moldova, and the migratory nature of larvae looking for plants with soft and juicy tissues for feeding, determines the numerical variations of a hybrid to another. The alive larvae identified by sectioning the plants at maturity varied greatly, their number being between 0.20 larvae/plant (Turda 165) and 0.60 larvae/plant (Turda 344), the average experience being 0.41 larvae/plant. Early genotypes showing a much smaller number of larvae of 0.30 larvae/plant (Turda 165 and Turda 248) while in the semi-early genotypes (Turda 344 and Turda 332) more larvae were identified, of 0.60 larvae/plant, than the experience average, of 0.41 larvae/plant.

Variations in the galleries length created are caused by food quality, but are also influenced by biochemical and physical factors. The length of galleries created by larvae had values assured as very significant, of 11.38 cm (Turda 344) and distinct significant, of 10.91 cm (Turda 332) at the semi-early genotypes, compared to the average, of 9.01 cm, in fact the two hybrids presented the most elevated number of larvae. The genotypes Turda 248 (6.88 cm) and Turda Star (6.89 cm) register length galleries assured as negative very significant compared to the average (Figure 5).

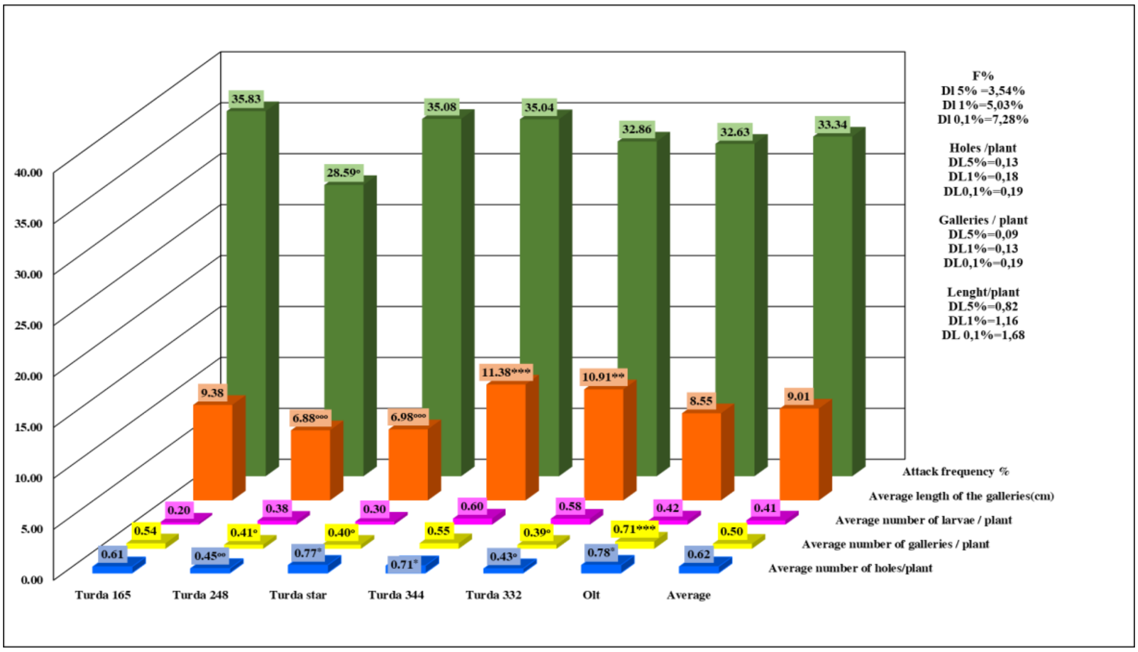

Figure 5. Evolution of the attack produced by the larvae of the species *Ostrinia nubilalis* Hbn. to different hybrids cultivated in the conditions of Central Moldova, average 2017-2020

Regarding the positioning of the galleries, under the cobs were registered the most numerous galleries with a share of 56% at the hybrids Turda Star, Turda 344, Turda 332 and Olt. Turda 248 had the highest share of galleries in the area above the cob, in percentage of 62.46%. The lowest number of galleries was registered in the panicle area in all hybrids analyzed, the share of galleries being between 2.69% and 7.77% (Figure 6).

From the graphical representation of the obtained results, it is found that both in terms of location on the plant, but also in terms of length, the galleries presented various sizes from one genotype to another. Turda 248 genotype recorded the longest galleries above the cob. The hybrids Turda Star, Turda 344 and Olt had the share with the longest galleries identified in the area under the cobs. In the case of the Turda 332 genotype, the plants showed galleries close in size in the areas below the cob and above the cob. Smaller galleries were identified in the area near the cob and from panicle to all studied hybrids (Figure 7).

The literature provides information on the influence of maize genotype, and it is mentioned that the number of plants affected by larvae is higher in early than late hybrids, which can be correlated with plant evolution, early genotypes having a faster growth rate. faster than the semi-late ones attracting females for laying eggs.

The comparative study, which included hybrids from four FAO groups (300, 400, 500, 600) by Lemic et al. (2019) of first-generation larvae in plants while the attack of second-generation larvae occurs in cobs and is much more intense in FAO group 400 and 500 genotypes.

Another study by Ivezić et al. (1997) show that the attack produced by larvae increases proportionally with the FAO group: group 300 registered 56.25% attack, hybrids from groups 400 showed attack of 66.01%, to genotypes from group 500 the attack was 65.14%, and to maize from group 600 the level of attack reached 71.76%.

The high pressure of the adult population of the first generation influences the level of attack produced by the second generation which materialized by reducing the production of semi-early hybrids. Rapid plant development, large size and number of leaves may be the characteristics that attract the first generation of *Ostrina nubilalis* (hibernate) for laying eggs (Lemic et al., 2019).

The maturity group together with the climatic conditions, especially the average temperature, relative humidity and precipitation in June have an important role in laying eggs and the appearance of larvae (Bazok et al., 2020).

In Romania, researchers teams aimed to obtain inbred maize lines with characteristics of resistance to the attack produced by *Ostrinia nubilalis*. The research conducted by Bărbulescu et al. (1999) through the artificial infestation with laying eggs led to the identification of new hybrid combinations with an acceptable degree of agronomic performance and resistance, highlighting lines with a low attack.

Georgescu et al. (2013) continued research to identify hybrids tolerant to the attack of the species and found a high variability of the attack produced by *Ostrinia nubilalis* on maize plants. During the experiment, the attack was greatly influenced by climatic conditions. Promising results were obtained at 67 lines characterized as resistant and environmentally resistant to larval attack, and among the hybrids analyzed, the Iezer genotype recorded different degrees of resistance.

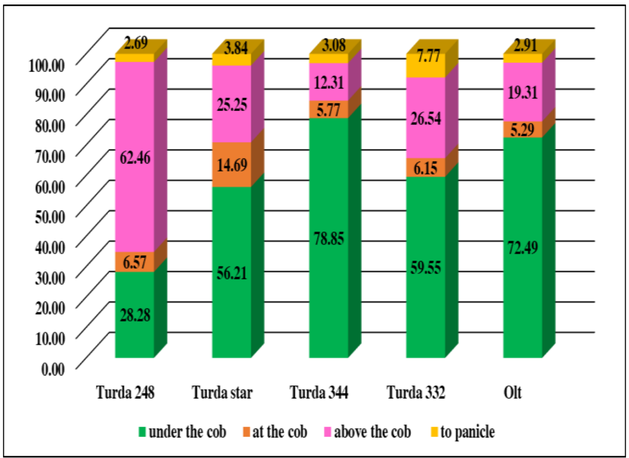

Figure 6. Share of galleries per plant at different hybrids, average 2019-2020

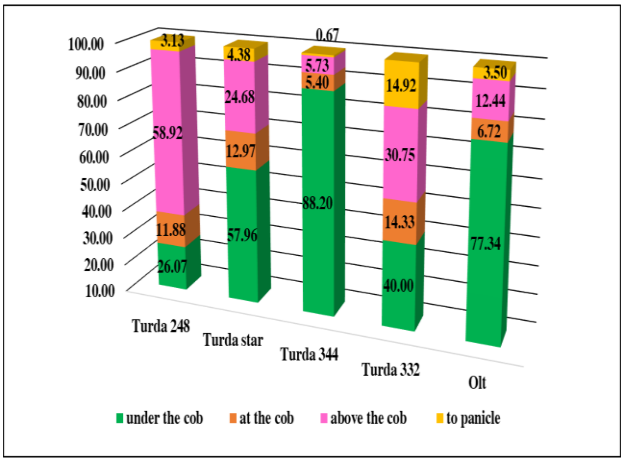

Figure 7. Share of galleries length per plant at different hybrids, average 2019-2020

Influence of chemical treatment

Although more difficult to achieve, the application of insecticides during the maize vegetation period is necessary if the economic threshold is exceeded.

The results obtained in the period 2019-2020 on the application of insecticides on vegetation showed a reduction at the level of attack in the maize crop, the untreated variant of the experience registering the highest attack compared to the treated variants (Figure 8). The frequency of the attacked plants varied from 9.39% (cyantraniliprol 200 g/l) to 15.43% (alpha-cypermethrin 50 g/l) and was assured as negative very significant for the variants where insecticide treatment was applied on the vegetation compared to the untreated variant which registered a higher attack, of 22.46%.

From the performed determinations it was found that the number of holes/plant was greatly reduced in the treated variants being between 0.12 holes/plant in the variant treated with cyantraniliprol 200 g/l and 0.23 holes/plant where tau-fluvalinate 240 g/l was applied, the values were assured as negative very significant compared with the untreated variant that had 0.36 holes/plant. Similar results were obtained for the number of galleries identified in the variants where insecticides were applied on vegetation, between 0.11 galleries/plant and 0.21 galleries/plant, which were well below the value of the untreated variant, of 0.34 holes/plant.

The number of larvae decreased to 0.03 larvae/plant at the variant where cyantraniliprol 200 g/l was applied compared to the untreated variant where 0.17 larvae/plant were identified (Figure 8).

The galleries created by the larvae to feed inside the plant recorded average lengths from 4.65 cm to 7.66 cm for the treated variants and were assured as negative very significant compared with the untreated variant which register galleries with dimensions of 10.61 cm.

Among the experienced insecticides, the active substance cyantraniliprol 200 g/l stands out with the best results, the rest of the products ensuring in different proportions the reduction of the attack (Figure 8).

The results obtained are similar to those published in the literature. The research team led by Vasileiadis et al. (2017) studied the effects of applying the active substances lambda cyhalothrin and cyantraniliprole in reducing the attack produced by the larvae of *Ostrinia nubilalis*. The determinations performed showed that the application of the active substances reduced the attack produced by the larvae, without having major effects on the useful entomofauna in maize crops.

In the experiment conducted by Franeta et al. (2018), the response of the defense system of *Ostrinia nubilalis* larvae following the application of the active substances indoxacarb, chlorantraniliprol and the combination of cyantraniliprol + lambda cyhalothrin was followed. The researchers concluded that the use of products containing these active substances negatively influenced the biochemical physiology of *Ostrinia nubilalis* larvae. Their study shows that these insecticides affect various aspects of insect biology, including the induction of oxidative stress, leading to changes in the life of the insect, reducing the development rate and ability to reproduce. Another aspect presented by Wei and Du (2004) was the effect of synthetic pyrethroids on larvae of different ages. The research show that adults that appear respectively males have a lower response to sex pheromones released, and surviving females produce and release more pheromones.

The study conducted by Gianessi (2014) in Asian countries states that the application of insecticides in the control of borer species has reduced the attack, with production increases of over 60%.

The application of insecticides reduces the attack of larvae, but a group of Chinese researchers draws attention to the risk of resistance to the active substance cyantraniliprol in the case of irrational application in maize crops (Zhi et al., 2021).

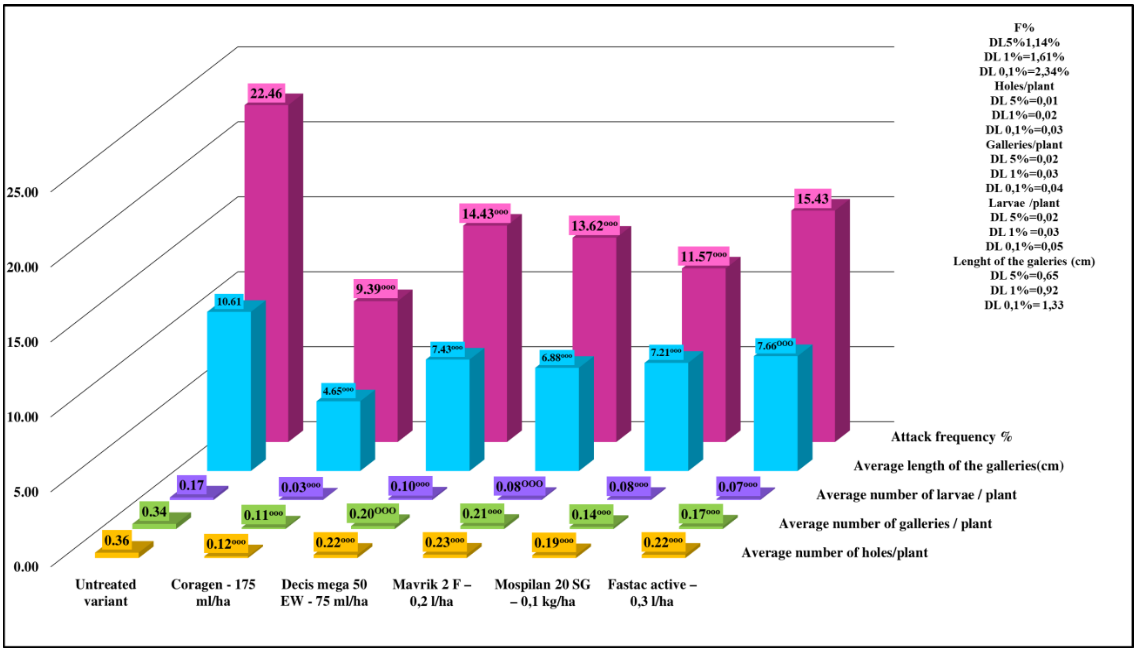

Figure 8. Evolution of the attack produced by the larvae of the species *Ostrinia nubilalis* Hbn. at maize following the application of treatment on vegetation with insecticides, average 2019-2020

CONCLUSIONS

The sowing epoch influenced the attack, the maize sown in the late epochs, IV and V which presented the highest values of the attack compared to the optimal epoch.

The lowest value of the attack frequency was 28.59% (Turda 248), and the highest was 35.83% (Turda 165).

The most numerous galleries and the longest galleries were identified in the area under the cobs compared to the panicle area, where their weight was much reduced.

Chemical treatment with insecticides reduced the attack of larvae ensuring the protection of maize plants, the variant treated with cyantraniliprol 200 g/l, the recorded attack was the lowest, of 9.4% and between 11.6% and 15.4%, at the rest of the variants by comparation with the untreated variant which recorded the highest attack of 22.5%.

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