BEHAVIOR OF SOME MAIZE HYBRIDS TO THE EUROPEAN CORN BORER (*Ostrinia nubilalis* HBN) ATTACK, AT NARDI FUNDULEA, 2013-2014

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Abstract

In this paper there were presented some results concerning testing of 18 maize hybrids to evaluate reaction at European corn borer attack (*Ostrinia nubilalis* Hbn.), in climatic conditions of the years 2013 and 2014, at NARDI Fundulea. Maize plants were artificial infested with ECB egg batches, produced in laboratory conditions, by rearing insects, successive generations, on continuous flux, using same artificial diet. Also, it has evaluated maize plants in conditions of ECB natural attack. Total number of egg batches obtained in laboratory was 133550 in 2013 and 159116 in 2014. Climatic conditions from summer period, registered at NARDI Fundulea, were more favorable for pest attack in 2014 comparative with 2013. Average natural attack frequency of the *O. nubilalis* at maize hybrids from the experiment was of 43.3 % in climatic conditions of the year 2013 and 79.4 % in climatic conditions of the year 2014. In case of artificial infestation of maize plants with ECB egg batches, average attack frequency was 91.7 % in 2013 and 95.5 % in 2014. Attack intensity was higher in 2014 comparative with 2013, both, at plants not infested and plants artificial infested. In both years, the differences between hybrids reaction to the attack of European corn borer were higher in case of artificial infestation, comparative with natural attack. Higher attack values, in both years, it has registered at Milcov, Paltin and F 59-09 hybrids while lower attack it has registered in case of F 475 M hybrid. Some maize hybrids have different reaction to ECB attack in 2013 comparative with 2014.

Key words: field testing, maize, artificial infestation

Cultivated on a surface higher then 2.500.000 hectares, maize is one of the most important crops from Romania (Faostat databases, 2014). European corn borer (*Ostrinia nubilalis* Hbn) is main pest of this crop in our country (Arion G., 1958; Paulian F. et al., 1976; Barbulescu A. et al., 2001; Popov C. et Barbulescu A., 2007). Early reports mentioned that maize yield losses in Romania, as result of ECB attack, can arrive at 60 % (Paulian F. et al., 1976). In the middle of the years '70, Sapunaru T. et Hatman M. (1975) reported yield losses, in different farms from Moldavia region, ranged from 1400 to 2360 kg/ha. In Transylvania, at the beginning of the years '80, Mustea D. (1981) reported yield loses because of ECB attack, from 5.4 to 9.8 %. More recent data from literature, suggest that average maize yield losses in Romania, because of ECB attack were 7.5 % (Popov C. et Rosca I., 2007). According same authors, on regions, average maize yield losses ranged from 1.3 % in Dobrogea, 8.5 % in Transylvania, 10.5 % in south of the Moldavia, 11.7 % in Baragan Plane, until 17.7 % in West Plane. After Cristea M. et al. (2004), *O. nubilalis* is main pest of the maize crop in western and central part of the Romania (Transylvania) while in south and south-east of the country is second pest like economical importance, after maize leaf weevil (*Tanymecus dilaticollis*). Even if important yield loses it hasn't reported in the literature after year 2000, however in the last years it has signalized again problems with this pest at maize crops in west part of the country (Alexandri A., 2011). According the author, possible explications for this situation is because of the climatic changes that can favor insect in first stages of development and high numbers of foreign cultivated hybrids with lack of information concerning resistance at *O. nubilalis*. Olesen J. et al. (2011) mention that climates changes from the Central and South-East Europe countries can have negative impact on local agriculture and, in same time, can favor pests attack. In last three years, in journals for farmers it was several reports concerning higher attack of ECB at maize crops, in north-west and even south-east of the Romania (Plants Health, 2012; Farm, 2013). In countries from East, Central and Western Europe there were many communications concerning higher incidence of this pest as result of the both, climate

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changes and new agricultural practices (Brookes G., 2008). It has reported increasing of the ECB number generations/year from 2 to 3, in Spain and France (Brookes G., 2007) or from 1 to 2 in Geneva lake area from Switzerland (Derron J., 2009) or Hungary (Keszthelyi S., 2010). Also, it has reported extend of the pest areas from south-west to north-east, in France (Brookes G., 2008), from south-west to north, in Germany (Gathmann A. et Rothmeier I., 2005), from south to north in Poland (Beres K. P. et Konefal T., 2010; Beres K. P., 2012) or from south-east to north-west in Hungary (Keszthelyi S. et al., 2006; Keszthelyi S., 2010). Climate changes can have positive effect on *O. nubilalis* pest (Kocmánková E. et al., 2010). Using mathematic models and three different climatic scenarios, author arrive at conclusion that increasing of the global average temperature in the future can have possible effect spreading of this insects to new areas from north and up to 800 m altitudes. Because of this situation is necessary extended the researches in Romania concerning behavior of both, new and current maize hybrids at *O. nubilalis* larva attack. At the middle of the years '70, at NARDI Fundulea, it has started researches concerning mass rearing of the European corn borer in laboratory conditions (Barbulescu A., 1977, 1978, 1979, 1980). The purpose of this activity was to obtain egg batches for researches concerning maize inbreed lines and hybrids behavior at *O. nubilalis* attack (Barbulescu A., 1981; Barbulescu A. et al., 1985; 1999; 2001; Barbulescu A. et Cosmin O., 1987; 1997; Mustea D., 1990). Also, it has tested chemical and biological control of this pest in conditions of the artificial infestation of the maize plants with ECB egg batches (Barbulescu A., 1989; Muresan F. and Mustea D., 1995; Rosca I. et Barbulescu A., 1997). In this paper there were presented results concerning field testing of some maize hybrids, produced at NARDI Fundulea, using artificial infestation, in different climatic conditions from summer period, years 2013 and 2014.

MATERIAL AND METHOD

The experiences were carried out at Plant and Environment Protection Collective from National Agricultural Research and Development Institute (NARDI) Fundulea, Calarasi County (latitude: 44,3; longitude: 24,1; alt.: 68 m).

In period 2013-2014 it has tested 18 maize hybrids produced at NARDI Fundulea, both in conditions of artificial infestation and natural attack (tables 4, 5). Maize plants were sowed in plots, 10 m length and 4.2 m width (six rows) that correspond on a surface of 42 sqm. Each maize hybrid was tested in for replications. Experimental plots were arranged according randomized blocks scheme. Artificial infestation of the maize plants it has made with *O. nubilalis* egg batches produced in laboratory conditions, on continuous flux, after a technology described by Barbulescu A. (1980). Larvae were growing on diet with main ingredient, bean flour. Laboratory conditions from the rearing larva chamber were: 27-28 ºC air temperature, between 60 and 90 % air relative humidity. The ventilation and light must be assigned all day. At the pupae stage, the rearing conditions in laboratory were: air temperature between 21 and 25 ºC, air relative humidity between 60 and 90 %, permanent ventilation and continuous dark. The moths were placed in cages for egg batches deposition. Rearing conditions must be similar with natural one, from the field. To stimulate egg-batches deposition, rearing conditions were: for 18 hours air temperature 27-28 ºC and 6 for hours, air temperature 20 ºC (simulation of the day-night alternation), also, air relative humidity between 82-85 %, permanent ventilation and dark. During rearing process it has registered average number pupae/rearing box, total number of the moths, female number and egg batches number.

For field assessments, with, 10-14 days before panicle emergence (second decade of the June), maize plants were infested with 10 egg batches/plant, twice, 5-6 days, between infestations. Egg-batches used for artificial infestation are in "black-head" stage, when larva head become visible. At each plot it has infested 20 plants. In 2013, maize plants were sowed in last decade of April and emerged at the beginning of May. However, because of climatic conditions, sowing data was delayed in 2014. As result maize plants were sowed in 8 May and emerged after 21 May. Because of this situation, in 2013 and 2014 it was different data of plant artificial infestation. Normal period for artificial infestation, in climatic conditions from south-east of the Romania is last decade of the June (Barbulescu A., 1981; Barbulescu A. et al., 2001). In this experiment, in 2013 plants were infested with ECB egg batches in normal period, at 20 and 25 June. However, because of the atypical climatic conditions, especially heavy rainfalls from spring that delay maize sowing and emergence, in 2014, artificial infestations it has made in 7 and 9 July. Attack level of the European corn borer at the maize plants were analyzed in autumn (September) after the end of maize vegetation period, before harvesting (BBCH 99). From each plot it has taken 20 maize plants that were artificial infested in the summer. Also It has taken 20 uninfested plants to evaluate natural attack of the *O. nubilalis*. For this assessments the stalks was cooped in twice and it has determined three parameters: attack frequency, gallery length (cm) per plant and number of the alive larva/plant. The correlations and statistical analyze were made, using Microsoft Excel, version 2003 and ARM, version 8.5.0 software.

RESULTS AND DISCUSSIONS

Data from *table 1* show that in 2013, it has obtained 133550 egg-batches while in 2014 it has obtained 159116 egg-batches in laboratory conditions, on same diet. Regard number of

average egg batches/female, there were major differences between two years. A possible reason was problems with ventilation system in rearing chambers, in 2014. However, total number of egg batches, obtained in laboratory conditions, in 2014 was enough for all field experiments in that year. In 2013 it has used a total number of 243 rearing boxes while one year later it has used 368 rearing boxes. Average number of pupae on rearing box, have higher values in 2014. As result, even if the average number of egg batches/female were lower in 2014 comparative with 2013, higher number of rearing boxes used in 2014 and higher value of average pupae/rearing box registered in same year have result a higher number of females and egg batches obtained in 2014.

Climatic conditions from summer period were different in the two years taken in study, at NARDI Fundulea. Average air temperature registered in June were higher in 2013 comparative with 2014 (*table 2*). Similar situation was registered in July. In 2013, average air temperature in June and July was over multiyear average (+0.8 °C) wile in 2014 was slight multiyear average (-0.2 °C). In frame of one month, temperatures varied from one decade to another. In third decade of June, 2013 when it has made artificial infestation of the maize plants with ECB egg batches, average air temperature was higher then temperature registered in first decade of July, 2014, when it has made artificial infestations. In both years, rainfalls amount from June and July were higher then multiyear average (*table 3*). Rainfalls registered in third decade of June, 2013, when it has made artificial infestation of the maize plants, were lower comparative with rainfalls registered in first decade of July, 2014, when it has made artificial infestation of the maize plants with *O. nubilalis* egg batches. Analyzing weather data from June and July, it has ascertained that in 2014 climatic conditions were more favorable for European corn borer attack at maize plants.

Analyzing data from *tables 4* and *5* it has ascertained that average natural attack of the *O. nubilalis* at maize hybrids from this experiment was of 43.3 % in climatic conditions of the year 2013 and 79.4 % in climatic conditions of the year 2014. Natural attack has lower values of the cavities length/plant and alive larva/plant in 2013. Except maize hybrid Paltin there were not high differences between maize hybrids in conditions of natural attack, 2013. One year later, as results of favorable climatic conditions from period when larva are in first stage, natural attack at the maize hybrids were higher. Average cavities length/plant from this experiment was of 6.6 cm and average alive larva/plant was of 1.1 (table 5). Attack at hybrids Milcov and Paltin were higher then average in 2014 (16.2 and 13.7 cm). At the rest of maize hybrids, in conditions of natural attack, in 2014, average cavities length/plant was bellow 10 cm. At hybrid Milcov the registered number of alive larva/plant was 3.0, while at hybrid Paltin it has registered 2.5 alive larva/plant.

At maize plants, artificial infested with *O. nubilalis* egg-batches, the attack values of this pest were different in two years of study. Also, in climatic conditions of the year 2013, average attack frequency was of 91.7 %, while average cavities length/plant was of 8.5 cm and average alive larva/plant was of 1.6 (*table 4*). The average values of the attack on maize hybrids from this experiment were higher in case of artificial infestation, comparative with natural attack, in 2013. Also, the differences between hybrids reaction to the attack of European corn borer were higher in case of artificial infestation, comparative with natural attack. At plants, artificial infested with ECB egg batches, in 2013, lower values of cavities length/plant has registered at maize hybrids F 475 M (3.8 cm), Crisana (6.5 cm) and Olt (6.9 cm) while higher value of this parameter registered in case of hybrids F 23-09 (10.7 cm), Paltin (10.7 cm), Milcov (10.9 cm) and F 8-08 (12.7 cm). Similar situation it has registered in case of other parameter of attack intensity, alive larva/plants. Highest values of this parameter registered at hybrids F 8-08 (3.1 larva/plant).

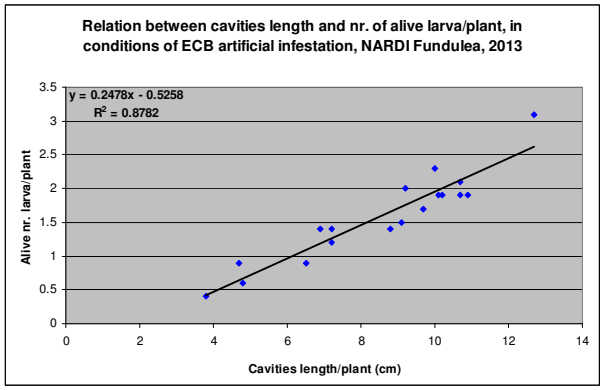

Figure 1 **Relation between cavities lenght and no. of alive larva/plant (2013)**

At hybrids Generos, Paltin and Campion it has registered 2.0 or higher value of larva/plants, in conditions of artificial infestations. Between average cavities length/plant values and average alive larva/plant values, it has registered positive correlation (*figure 1*), in conditions of maize artificial infestation with ECB egg batches, in climatic conditions of year 2013.

In 2014, at maize plants artificial infested, average attack frequency was of 95.5 %, while average cavities length/plant was of 10.7 cm and average alive larva/plant was of 2.0 (*table 5*).

Table 1

Data concerning mass rearing of the European corn borer (*Ostrinia nubilalis* Hbn), in controlled laboratory conditions, în continuous flux, on the same artificial diet, period 2013-2014

Specification	2013	2014
Number of the rearing boxes	243	368
Average number of the pupae/box	525	579
Total number of the moths	115112	230155
Total number of the females	51799	103621
% female	45.01	45.00
Total number of the egg-batches	133550	159116
Average nr. egg-batches/female	2.6	1.5

Table 2

Temperatures registered at NARDI Fundulea, during June-July, period 2013-2014

Year	Temperatures (℃)						Average (℃)	Multiyear Average June-July (℃)	Deviation (℃)
	June			July					
	Decade I	Decade II	Decade III	Decade I	Decade II	Decade III			
2013	18.5	21.6	23.3	21.9	23.8	24.1	22.4	21.6	**+0.8**
2014	20.2	19.4	19.8	22.3	22.6	24.0	21.4	21.6	**-0.2**

Table 3

Rainfalls registered at NARDI Fundulea, during June-July, period 2013-2014

Year	Rainfalls (mm)						Total (mm)	Multiyear Average June-July (mm)	Deviation (mm)
	June			July					
	Decade I	Decade II	Decade III	Decade I	Decade II	Decade III			
2013	42.9	19.8	64	44.2	5.3	46.6	176.2	143.7	**+32.5**
2014	14.7	70.9	50.5	36.6	12.9	2.6	185.6	143.7	**+41.9**

Table 4

Behavior of maize hybrids at attack of the *O. nubilalis*, at NARDI Fundulea, in 2013

Hybrid	Uninfested plants			Plants artificial infested		
	Attack frequency (%)	Cavities length/plant (cm)	Alive larva/plant	Attack frequency (%)	Cavities length/plant (cm)	Alive larva/plant
Olt	50	2.2	0.4	85	6.9	1.4
Crişana	60	3.4	0.2	90	6.5	0.9
Mostiştea	80	3.2	0.5	100	9.7	1.7
Rapsodia	50	3.1	0.9	95	10.1	1.9
F376	50	3.1	0.7	95	9.1	1.5
Paltin	90	7.5	1.9	90	10.7	2.1
Iezer	50	2.1	0.4	80	4.7	0.9
F 475 M	60	2.8	0.3	65	3.8	0.4
F 59-09	10	0.5	0.1	100	7.2	1.4
Milcov	40	4.2	1.0	95	10.9	1.9
F 23-09	60	5.8	1.3	95	10.7	1.9
Campion	40	2.4	0.6	100	9.2	2.0
F 170-08	10	0.3	0.1	100	10.2	1.9
F 133-08	40	2.3	0.4	85	7.2	1.2
F 131-08	50	1.9	0.4	80	4.8	0.6
F 8-08	30	1.1	0.3	100	12.7	3.1
Danubian	10	0.1	0	95	8.8	1.4
Generos	0	0	0	100	10.0	2.3
Average	**43.3**	**2.6**	**0.5**	**91.7**	**8.5**	**1.6**
Minim	**0**	**0**	**0**	**65**	**3.8**	**0.4**
Maxim	**90**	**7.5**	**1.9**	**100**	**12.7**	**3.1**

Table 5

Behavior of maize hybrids at attack of the *O. nubilalis*, at NARDI Fundulea, in 2014

Hybrid	Uninfested plants			Plants artificial infested		
	Attack frequency (%)	Cavities length/plant (cm)	Alive larva/plant	Attack frequency (%)	Cavities length/plant (cm)	Alive larva/plant
Olt	90.00	6.5	1.2	90.00	14.4	2.8
Crişana	50.00	3.9	0.6	90.00	9.1	1.9
Mostiştea	100.00	8.9	1.6	100.00	14.4	2.2
Rapsodia	90.00	9.8	1.1	100.00	10.2	1.6
F376	100.00	6.8	1.3	100.00	13.4	3.3
Paltin	90.00	13.7	2.5	100.00	14.5	2.8
Iezer	80.00	6.9	1.4	90.00	8.0	1.5
F 475 M	80.00	4.0	0.5	90.00	4.2	0.6
F 59-09	90.00	3.1	0.5	100.00	13.0	2.1
Milcov	100.00	16.2	3.0	90.00	19.9	3.6
F 23-09	100.00	8.0	1.4	90.00	8.4	1.9
Campion	80.00	4.7	1.1	100.00	7.9	1.7
F 170-08	70.00	4.3	0.4	100.00	8.1	1.3
F 133-08	100.00	9.2	1.7	100.00	10.7	2.2
F 131-08	50.00	2.1	0.5	100.00	7.2	1.3
F 8-08	60.00	2.3	0.5	80.00	8.5	1.6
Danubian	0.00	0.0	0	100.00	9.0	1.6
Generos	100.00	7.8	1.3	100.00	10.9	1.9
Average	**79.4**	**6.6**	**1.1**	**95.5**	**10.7**	**2.0**
Minim	**0**	**0**	**0**	**80**	**4.2**	**0.6**
Maxim	**100**	**16.2**	**3.0**	**100**	**19.9**	**3.6**

Even if the average attack frequency of intensity were lower between natural attack variants and artificial infested maize plants in 2014, as result of the favorable climatic conditions for pest developments, however in case of artificial infested plants, differences between hybrids reaction are higher comparative with natural attack assessments.

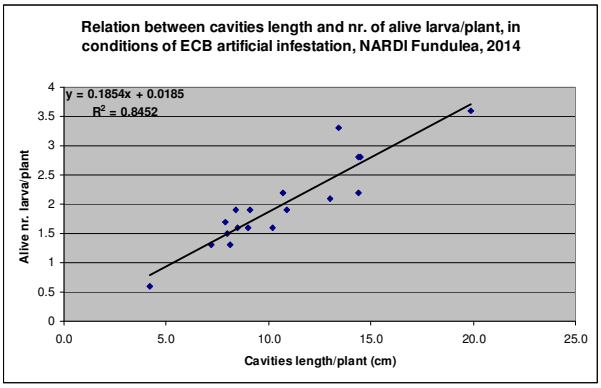

Figure 2 **Relation between cavities lenght and no. of alive larva/plant (2014)**

Except maize hybrids F 8-08, F 23-09, Milcov, F 475 M, Iezer, Crisana and Olt, the attack frequency in conditions of artificial infestations was 100 % in 2014. In case of natural attack, only in case of 5 maize hybrids it has registered maximum attack frequency (table 5). At maize artificial infested plants, with ECB egg batches, highest value of cavities length/plant it has registered in case of Milcov hybrid (19.9 cm). At same hybrid from the experiment it has registered highest value of alive larva/plant, in 2014 (3.6 larva). Between average cavities length/plant values and average alive larva/plant values, it has registered positive correlation (*figure 2*), in climatic conditions of year 2013. In both years, maize hybrids have different reactions at the attack of *O. nubilalis*. More accurate results were obtained in conditions of maize artificial infestation with ECB egg batches.

CONCLUSIONS

In 2013 it has obtained 133550 egg-batches and in 2014 it has obtained 159116 egg-batches in laboratory conditions, on same diet. Average egg batches/female was of 1.5 in 2014 and 2.6 in 2013.

Climatic conditions for European corn borer attack at maize plants were more favorable in 2014 comparative with 2013.

In case of natural attack, the differences between hybrids reaction at ECB attack were lower comparative with artificial infestation of plants.

In both years, the correlation between average cavities length/plant and alive larva/plant were positive. Artificial infestation is an effective method to evaluate maize hybrids reaction at *O. nubilalis* attack, in different climatic conditions.

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