THE PERSPECTIVES TO USE AN ORGANIC EXTRACT FROM THE *FABACEAE* FAMILY TO CONTROL THE MAIZE LEAF WEEVIL (*TANYMECUS DILATICOLLIS* GYLL) AT THE MAIZE CROP IN ROMANIA

Emil GEORGESCU[1], Lidia CANĂ[1], Maria TOADER[2], Luxița RÂȘNOVEANU[3,4]

e-mail: emilgeorgescu2013@gmail.com

Abstract

In this paper, we present results of two years study, in the field conditions, at NARDI Fundulea, located in the south-east of Romania, concerning the effectiveness of the biological control of the maize leaf weevils (*Tanymecus dilaticollis* Gyll) at maize crops, with organic insecticide on a base of plant extracts from the *Fabaceae* family (0.3 %) applied both, like seed coating and foliar spray. It has assessed weevils attack intensity at maize plants on a scale from 1 (plants not attacked) to 9 (plants complete destroyed), saved plants percent at 30 days from maize emergence and plants height at 50 days from plants emergence. At maize untreated plants, the weevils attack intensity was 3.16 in 2020 and 5.71 in 2021, while at variants treated with organic insecticide on a base of plant extracts from the *Fabaceae* family the weevils attack intensity ranged from 3.08 to 3.14 in 2020 and from 5.65 to 5.68 in 2021. The lowest value of the weevils attack intensity was registered in the case of the variant with seeds treated with imidacloprid active ingredient (I=2.56 in 2020; I=4.46 in 2021). The highest values of saved plants percent were registered in the case of the variant with seeds treated with imidacloprid (94.04 % in 2020, respectively 86.80 % in 2021). In this two-year study, in field conditions, in the southeast of Romania, it hasn't registered significant statistical differences concerning weevils attack registered at untreated maize plants and maize variants treated with organic insecticide on a base of plant extracts from the *Fabaceae* family (0.3 %). Both years haven't registered significant statistical differences concerning plant heights at 50 days from the maize emergence.

Key words: maize, weevils, organic insecticide, attack

According to MADR data (2021), maize is one of the most cultivated crops in Romania. In the last years, the area sowed with this crop ranged between 2.40 and 2.68 million hectares, representing the highest area in the European Union (Eurostat database, 2019). Insects attack is one of the limitative factors for the maize yield in Romania (Bărbulescu A. *et al*, 1997; 2001a; Popov C., Bărbulescu A., 2007; Trotuș E. *et al*, 2013; Trașcă F. *et al*, 2019). Trotuș E. *et al* (2011) mentioned that, in some years, only because of the pests attack, maize yield losses can arrive at 23 %. Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is the main pest of maize crop, mainly in south and south-east of Romania (Paulian F., 1972; Voinescu I., 1985; Voinescu I., Bărbulescu A., 1998; Popov C. *et al*, 2002, 2003, 2007a; Georgescu E. *et al*, 2014, 2018). The weevils attack occurred when maize plants are in early vegetation stages, from emergence until four leaves stage; in case of high pest pressure, economically damages can be significant (Roșca I., Istrate R., 2009). The same authors mentioned that the weevils attack could occur when maize plants are in the five or six leaves stage (BBCH 15-BBCH 16), but in this case, the adult insects feeding only with leaves margins and economically damages are not significant. Recent data from the Romanian literature evidence that maize leaf weevil is present and produces significant damages in areas considered, until now, less favorable for this species (Antonie I. *et al*, 2012: Badiu A.F. *et al*, 2019). Possible explication for this fact is climate change and global warming (Olesen J.E., 2011; Daniel P.B. *et al*, 2013; Deutch C.A. *et al*, 2018; Miedaner T., Juroszek, P., 2021). According to Čamprag D. (2007) many pests can be favored by climate changes such as increasing the temperature in northern latitudes. Other studies reveal that as o consequence of global warming will increase the prevalence of insect pests in many agro-ecosystem, including maize crop too (Diffenbaugh N.S. *et al*, 2008; Hakala K. *et al*, 2011; Maxem A., 2013). Drought and high temperatures are favorable

[1]National Agricultural Research Development Institute (NARDI), Fundulea, Romania
[2]University of Agronomic Sciences and Veterinary Medicine from Bucharest, Romania
[3]Bucharest University Economic Studies, Faculty of Agri-food & Environmental Economics, Bucharest, Romania
[4]Agricultural Research Development Station Braila, Romania

conditions for maize leaf weevils to attack (Popov C. *et al*, 2006). The insects are very active at temperatures higher than +18 °C, at the soil surface; usually, this period coincides when maize plants are in the early vegetation stages (BBCH 10-BBCH 14)(Roșca I., Istrate R., 2009). Paulian F. (1972) reported that in case of higher weevil's density (25 and 30 insects/m^2) maize yield losses can reach at 34 %. However, between 1980 and 2000 it has reported higher weevil's densities in the favorable area of this species, ranged between 15 and 80 insects/m^2 (Bărbulescu A. *et al*, 2001a; Popov C., Bărbulescu A., 2007). In some extreme cases it has reported a pest density of 160 weevils/m^2 in the Dobrogea area (Voinescu I., 1987 cited by Roșca I., Istrate R., 2009). Reports after the year 2000 reveal that in the favorable areas of maize leaf weevils, from south and south-east of Romania, every year are attacked one million hectares cultivated with maize (Popov C. *et al*, 2002, 2004, 2007a). Recent studies make in evidence maize density losses, as a result of the weevils attack, ranged from 25 to 50 % (Badiu A. *et al*, 2019). Seed treatment with systemic insecticide with a high solubility degree and rapid translocation of the active ingredient to the young plants was the most effective method to protect maize plants in early vegetation stages against maize leaf weevil attack (Bărbulescu A. *et al*, 2001b; Vasilescu S. *et al*, 2005; Čamprag D., 2007; Popov C. *et al*, 2007b; Popov C., Bărbulescu A., 2007; Trotuș E. *et al*, 2011, 2019; Georgescu E. *et al*, 2014, 2018). As a result of the European Commission Regulations 218/783, 218/784, and 218/785, the use of imidacloprid, clothianidin, and thiamethoxam active ingredients for all field crops, both like seed treatment and foliar application, will be banned in UE, from 2019 (Official Journal of the European Union, 2018a,b,c). After these relegations no insecticides remain available for maize seed treatment against maize leaf weevils attack, in Romania. Lack of effective control methods of this pest at maize crop can have negative effect for the farmer's profitability in our country in conditions of global warming that can favor harmful insect's species for field crops. In past years it has done researches for finding possible alternatives at maize seed treatment with systemic insecticides for controlling the maize leaf weevil attack. It has studied both foliar and seed treatment with chemical insecticides and plant extracts, however the effectiveness of these treatments in controlling of maize leaf weevil was lower compared with seed treatment with banned systemic insecticides (Georgescu E. *et al*, 2014; 2018, 2021; Toader M. *et al*, 2020). In Romania it has done researches concerning botanical extracts from the *Fabaceae* family for controlling the pests attack in the orchards, but the effectiveness of these products for controlling of the *Eurytoma schreineri* and aphids at plum trees was low (Moldovan C. *et al*, 2020a,b). The present study aims to determine if botanical extract from the *Fabaceae* family, used in biological control of the pests of vegetable crops or orchards, can be an effective solution for maize crop protection against weevils attack.

MATERIAL AND METHOD

The field trial was carried out at Agricultural Engineering Laboratory from National Agricultural Research and Development Institute (NARDI) Fundulea, Călărași County, Romania (latitude: 44.46; longitude: 26.32; alt.: 68.00 m, between 2020 and 2021.

This research tested an organic insecticide on a base of botanical extracts from the *Fabaceae* family (0.3%) (commercial name Deffort) and applied both seed treatment (BBCH 00) and foliar treatment (when maize plants were in BBCH 11-12 stages). These two variants of applications were compared with imidacloprid (600 g/l) active ingredient, applied like seed treatment (commercial product dose 8 l/to). For seeds treatment, the dose of the *Fabaceae* extract organic insecticide was 2.0 l/to. and dose for foliar application was 2.5 l/ha.

Experimental plots were arranged according to the randomized blocks scheme. The plot length was 10 m, the plot with 4.2 m, and the result plot area was 42 m^2. In 2020 plants were sowed on 14 April while in 2021 plants were sowed on 6 May. For this study, it has used the F423 maize hybrid (FAO group 401-500).

Weevils attack intensity is evaluated when the maize plants is in four leaves stage (BBCH 14), according to a scale from 1 to 9, elaborated by Paulian F. (1972) and improved by Bărbulescu A. (2001b), as follows: note 1-plant not attacked; note 2-plant with 2-3 simple bites on the leaf edge; note 3-plants with bites or clips on all leaves edge; note 4-plants with leaves chafed in proportion of 25 %; note 5-plants with leaves chafed in proportion of 50 %; note 6-plants with leaves chafed in proportion of 75 %; note 7-plants with leaves chafed almost at the level of the stem; note 8-plants with leaves completely chafed and beginning of the stem destroyed; note 9-plants destroyed, with stem chafed close to soil level. At each plot it has evaluated 20 maize plants, from four central rows (5 plant/row). Before assessment plants were marked with sticks, in stair system.

After 30 days from the plants emergence it has evaluated **saved plant percent** by counting all the emerged plants from a plot and comparing them with the sowing seeds number/plot.

Plants height at 50 days from maize emergence was assessed at same plants that, previously it has made observations concerning attack intensity.

Meteorological data was provided by Meteo station of the NARDI Fundulea. It has monitoring air temperature and rainfalls during spring period (March-May). Data from the field assessments was **statistical analyzed** using Student-Newman test.

Table 1

Average air temperatures registered at NARDI Fundulea, during spring, in 2020 and 2021

Year	**Average air temperature (°C)**						**Deviation from the average (°C)**		
	March		April		May		March	April	May
	Current year	Multiyear average	Current year	Multiyear average	Current year	Multiyear average			
2020	**8.3**	4.9	**12.3**	11.3	**17.0**	17.0	**+3.4**	**+1.0**	**0**
2021	**5.1**	4.9	**9.7**	11.3	**17.2**	17.0	**+0.2**	**-1.6**	**+0.2**

Table 2

Rainfall amounts registered at NARDI Fundulea, during spring, in 2020 and 2021

Year	**Rainfall amounts (°C)**						**Deviation from the average (mm)**		
	March		April		May		March	April	May
	Current year	Multiyear average	Current year	Multiyear average	Current year	Multiyear average			
2020	**29.8**	37.4	**14.0**	45.1	**58.0**	62.5	**-7.7**	**-31.1**	**-4.5**
2021	**59.0**	37.4	**31.0**	45.1	**57.6**	62.5	**+21.6**	**-14.1**	**-4.9**

Table 3

Results of the field trial in the spring of the year 2020

Nr. crt.	**Variant** (active ingredients)	**2020**									
		Phytotoxicity (%)		Attack incidence (%)		Attack intensity (1-9)		Saved plants (%)		Plants height (cm)	
1	Check (untreated)	0	a	100	a	3.16	a	91.67	a	153.06	a
2	Imidacloprid (600 g/l) seed treatment	0	a	100	a	2.56	a	94.03	a	156.88	a
3	Deffort (*Facaceae* extract)-seed treatment	0	a	100	a	3.14	a	91.94	a	154.14	a
4	Deffort (*Facaceae* extract)-foliar spray	0	a	100	a	3.08	a	91.31	a	153.50	a
LSD P=0.05		0		0		0.515		5.437		12.539	
Standard deviation (SD)		0		0		0.322		3.399		7.840	
Variation coefficient (C.V.)		0		0		10.770		3.690		5.080	
Replicate F		0		0		0.187		1.608		0.965	
Replicate Prob(F)		1.0000		1.0000		0.9026		0.2551		0.4504	
Treatment F		0		0		3.158		0.517		0.191	
Treatment Prob(F)		1.0000		1.0000		0.0787		0.6811		0.9001	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls test)

Table 4

Results of the field trial in the spring of the year 2021

Nr. crt.	**Variant** (active ingredients)	**2021**									
		Phytotoxicity (%)		Attack incidence (%)		Attack intensity (1-9)		Saved plants (%)		Plants height (cm)	
1	Check (untreated)	0	a	100	a	5.71	a	72.64	b	200.19	a
2	Imidacloprid (600 g/l) seed treatment	0	a	100	a	4.46	b	86.80	a	209.94	a
3	Deffort (*Facaceae* extract)-seed treatment	0	a	100	a	5.68	a	72.78	b	200.41	a
4	Deffort (*Facaceae* extract)-foliar spray	0	a	100	a	5.65	a	73.33	b	202.75	a
LSD P=0.05		0		0		0.724		9.576		28.454	
Standard deviation (SD)		0		0		0.453		5.987		17.790	
Variation coefficient (C.V.)		0		0		8.420		7.84		8.750	
Replicate F		0		0		1.010		1.449		0.526	
Replicate Prob(F)		1.0000		1.0000		0.4323		0.2924		0.6753	
Treatment F		0		0		7.234		5.388		0.263	
Treatment Prob(F)		1.0000		1.0000		0.0090		0.0213		0.8505	

Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls test)

RESULTS AND DISCUSSIONS

Data from *tables 1 and 2* show that weather conditions registered in the spring at NARDI Fundulea were atypical. In 2020, the average air temperature recorded in March and April was higher than the multi-year average, while in May, the average air temperature was typical for this period. In 2021, the average air temperature recorded in all spring months was higher than multi-year averages. Concerning rainfalls amount registered during the spring period, at NARDI Fundulea, analyzing the data from *tables 1 and 2* it has ascertained that with exception of March 2021, in all spring months it has registered lower rainfalls amount compared with multiyear averages. However, in May 2020 and May 2021, it has registered a slight negative deviation of the rainfalls amount from the average.

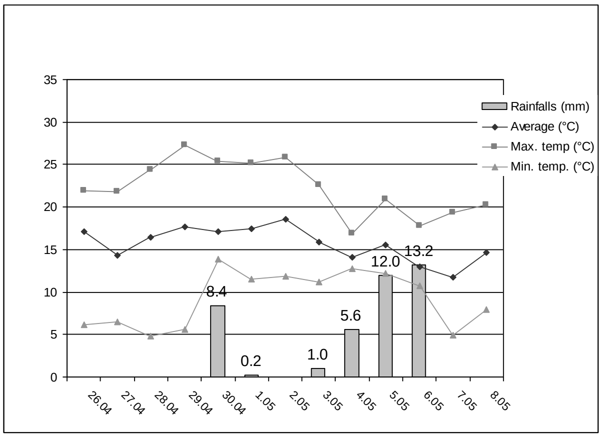

Figure 1. Daily temperatures and rainfalls recorded between maize plants emergence (BBCH 10) and four leaves stage (BBCH 14) at NARDI Fundulea in the spring of the year 2020

Temperatures and rainfalls occurred when maize plants are in early vegetation stages (BBCH 10-BBCH 14) influenced weevil's activity on the ground and attack intensity at maize plants (Popov C. *et al*, 2006; Roșca I., Istrate R., 2009). Analyzing the daily temperatures and rainfalls recorded between maize plants emergence (BBCH 10) and four leaves stages (BBCH 14) in spring of 2020 at the experimental field from NARDI Fundulea it can observe the high difference between the daily minimum and maximum temperature in the first three days after the emergence of the maize plants. This difference was higher than 21 °C on 29April (*Figure 1*). As a result, a favorable period during the day for weevils activity on the ground was concise. From 30 April until 6 May, it has registered 40.4 mm of rains and the temperatures decreasing. Because of unfavorable weather conditions for weevil's activity, registered between maize plants emergence (BBCH 10) until four leaves stages (BBCH 14), the attack of the maize leaf weevil at maize plants was low.

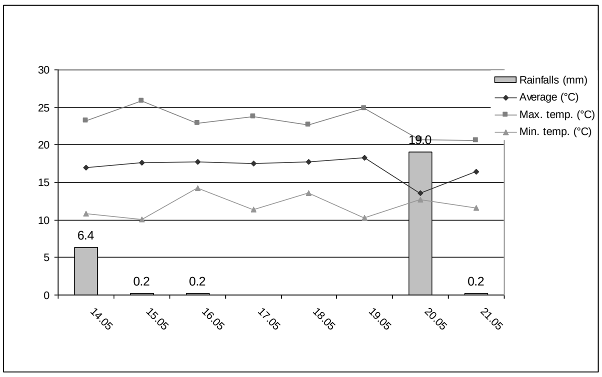

Figure 2. Daily temperatures and rainfalls recorded between maize plants emergence (BBCH 10) and four leaves stage (BBCH 14) at NARDI Fundulea in the spring of the year 2021

In the spring of 2021, in the experimental field from NARDI Fundulea in all 8 days from maize emergence until four leaves stage, the maximum air temperature was higher than 20 °C while the minimum air temperature was higher than 10 °C. However, rainfalls registered two days before maize plants arrive in four leaves stage have consequences in lower weevil's activity on the ground (*Figure 2*). Analyzing the daily distribution of the temperatures and rainfalls registered in the most sensitive period of the maize plants to weevils attack, it can conclude that in spring of 2021, it was the most favorable conditions for maize leaf weevil attack at the experimental field from NARDI Fundulea.

Data from *table 3* reveal that the attack intensity of the weevils at maize plant untreated plants was low (I=3.16). At variants treated with a botanical extract from the *Fabaceae* family, the attack intensity ranged from 3.08 to 3.14. Lower attack intensity from this trial has registered variant with treated seeds with imidacloprid active ingredient. However, **the low weevils attack intensity in spring of 2020** hasn't reported significant statistical differences between experimental variants ($p<0.05$). The weevil's attack intensity at maize plants was higher in the spring of 2021. At the control (untreated) variant, on a scale from 1 to 9, the weevils attack intensity was 5.71. The majority of the plants from untreated variant have leaves chaffed in the proportion of 50-

75 %, and some of the plants have all leaves destroyed as a result of the weevils feeding process. It has registered only slight differences between untreated variants and variants treated with a botanical extract from the *Fabaceae* family, both like seed and foliar treatment. The lowest weevils attack intensity value in the spring of 2021 was registered in maize plants with treated seeds with imidacloprid active ingredients (*table 4*). According to Student-Newman-Keuls (SNK) test, in the spring of 2021, the highest statistical difference, compared with control untreated (variant) it has registered in the case of standard variant, with treated seeds with imidacloprid active ingredient ($p<0.05$). As a result of the lower attack intensity registered in spring of 2020, saved plants percent was higher than 91 % in all variants from this trial. Even if the highest value of the saved plant's percent has registered in the case of variant treated with imidacloprid active ingredient (94.03 %), it hasn't registered significant statistical differences between variants ($p<0.05$). In spring of 2021, it hasn’t registered a significant statistical difference between saved plants percent at control variant and saved plants percent at variants treated with a botanical extract from the *Fabaceae* family, both like seed and foliar treatment. The statistical differences between saved plants percent registered in case of variant treated with imidacloprid active ingredient and the rest of the variants from this trial were significant in the spring of 2021 ($p<0.05$). At 50 days from the maize emergence, plants' height ranged from 153.06 to 156.88 cm in 2020 and from 200.19 to 209.94 cm in 2021. In both years, higher values of the plant's height at 50 days from the maize emergence have registered in the case of standard variant, with maize with treated seeds with imidacloprid active ingredient. However, the differences compared with the other variants from this trial were slight and weren’t statistically assigned ($p<0.05$). In this study, the organic insecticide on a base of plant extracts from the *Fabaceae* family didn’t control the maize leaf weevil attack at maize crops, when plants are in the early vegetation stages (BBCH 10-BBCH 14).

CONCLUSIONS

During this trial, at NARDI Fundulea experimental field, weather conditions registered from maize plants emergence until four leaves stage were unfavorable for maize leaf weevils (*T. dilaticollis*) in spring of 2020 and favorable in spring 2021.

The maize leaf weevil (*T. dilaticollis*) attack at maize plants was lower in the spring of 2020 and moderate in the spring of 2021.

In this trial, in the low or moderate pest pressure conditions, the weevils attack intensity registered at the maize experimental variants treated with organic insecticide on a base of plant extracts from the *Fabaceae* family (0.3 %) was almost similar with weevils attack intensity registered at untreated maize plants.

In both years of this field study, the lowest weevils attack intensity has registered in the case of the variant with maize seeds treated with imidacloprid active ingredient.

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