IS BIOLOGICAL CONTROL A SOLUTION FOR MAIZE PLANTS PROTECTION AGAINST MAIZE LEAF WEEVIL (*TANYMECUS DILATICOLLIS* GYLL) ATTACK IN CLIMATIC CONDITIONS SPECIFIC FROM SOUTH-EAST OF THE ROMANIA?

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Abstract

Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is the most dangerous pest of the maize, in south and south-east of the Romania. The attack is dangerous when maize plants are in first vegetation stages (plants emergence-four leaf stage, BBCH 10-BBCH 14), in some cases maize crop can be total destroyed. Each year, in maximum favorable areas for this pest, there is attacked, with different intensity degrees, one million hectares cultivated with maize. Seeds chemical treatment with systemic insecticides represented the most efficacy method of maize crops protection against attack of this pest, in climatic conditions specific for south east of the Romania. As result of the EU directive 485/2013, starting from year 2014, the use of the neonicotiond insecticides (imidacloprid, clothianidin, thiametoxan active ingredients) for spring crops seeds treatment, was restricted. However, in perioad 2014-2018, Romania obtained derogations for use of these insecticides for seed treatment of maize and sunflower crops. As result of EU states vote, in 27 April, 2018, it has decided total ban of using of this three active ingredients from neonicotinoids class at all field crops, starting from 2019. As result, in Romania, at maize crop, no active ingredient will remain available for seed treatment against maize leaf weevil attack. In this paper there were presented results of a three-year study, effectuated at NARDI Fundulea, concerning the efficacy of the biological insecticides, used both at seed treatment and foliar spraying (spinosad active ingredient and neem oil) comparative with seed treatment with imidacloprid active ingredient (600 g/l). In the three study years, the lowest attack level of the *Tanymecus dilaticollis* at maize plants it has registered in case of the variant with seeds treated with imidacloprid. In climatic conditions specific from south-east of Romania, in period 2016-2018 there weren't statistical differences ($p<0.5$) between control (untreated) variant and variants treated with biological products, both like seed treatment and foliar spraying.

Key words: maize, pest, control, insecticide, efficacy

Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is a serious pest problem of the maize crops in Romania (Paulian F. *et al*, 1969, 1977; Barbulescu A. *et al*, 1997; Barbulescu A., 2001; Popov C., 2002; Popov C. *et al*, 2007a; Cristea M. *et al*, 2004). Each year, there were attacked approximate one million hectares cultivated with maize (Popov C. *et al*, 2007). According Paulian F. (1972) the weevils attack is very dangerous when maize plants are in first vegetation stages, from plant emergence (BBCH 10) until four leaf stage (BBCH 14). In case of high pest pressure and lack of the treatments, maize plants can be destroyed and farmers must sow again (Čamprag D. *et al*, 1969; Paulian F. *et al*, 1974; Kacso, A., 1974; Popov C. *et al*, 2007b). After BBCH 14 stage, the adults feeding only with leaf margins and the attack are not economically important (Rosca I. *et al*, 2009).

Researches effectuated in last decades make in evidence that the most favorable area of *Tanymecus dilaticollis* in Romania is located in south and south-east of the country (Paulian F., 1972: Cristea M. *et al*, 2004; Popov C. *et al*, 2007). In this area it has registered highest damages at maize crop, produced by this pest. According Popov *et al*, (2006), maize leaf weevil is a thermo- and xerophilous insect, spread especially in arid and semi-arid areas, from south and south-east of the Romania. Same author mentioned that the adults are very active at high temperatures and low humidity while the low temperatures and high rainfall interfere very much with their activity.

However, recent studies make in evidence important attack of the *Tanymecus dilaticollis* at

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the maize plants, in areas considered until now, unfavorable for this pest activity, such as Transylvania (Antonie I. *et al*, 2012). Also, unpublished reports signalized high attack of this pest in North East of the Romania, in recent years (Plants Health, 2015). Possible explication for maize leaf weevil occurrence in northern areas from Romania is because of the climatic changes. Many pests can be favored by climatic changes such as increasing of the temperature in northern latitudes (Čamprag D., 2011; Karuppaiah V. *et al*, 2012; Daniel P.B. *et a*., 2013). Long term studies on precipitation evolution show a decreasing trend, especially in spring period (Bozo L., 2011). Same author mentioned that sometime, increasing precipitations is visible as a shorter term tendency.

Barbulescu A. *et al* (2001) mentioned that the traditional practice of cropping maize after maize for several consecutive years greatly contributes to the reproduction of this insect and thus to an increase in its population. At same conclusion arrive Voinescu I. *et al* (1998). In last 25 years, in Romania the number of main crops decreasing. As result it has increasing the area with crops sowed in monoculture, including maize (Lup A. *et al*, 2013).

Several researches made in Romania and other countries from South-East of the Europe make in evidence that chemical seed treatment with systemic insecticides is the most effective method to protect maize young plants from *Tanymecus dilaticollis* attack in spring (Voinescu I., 1985: Barbulescu A. *et al*, 2001; Vasilescu S. *et al*, 2005; Krusteva H. *et al*, 2006; Čamprag D., 2007; Popov *et al*, 2007; Keszthelyi S. *et al*, 2008; Trotus E. *et al*, 2011; Georgescu E. *et al*, 2014a, 2015). As result of EU directive 485/2013, from 1 December 2013, the use of three neonicotinoid active ingredients were restricted for seed treatment of oilseed rape and spring crops, including maize (Official Journal of the European Union, 2013). After this directive no insecticides remain available for maize seed treatment against *T. dilaticollis* in Romania. Because of the lack of alternatives at seed treatment of the spring crops (maize and sunflower), Romania obtained temporary authorizations for use of the neonicotinoids between 2014 and 2018. However, after 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 total banned in UE, from 2019 (Official Journal of the European Union, 2018a, b, c). According MADR data (2017) in last years, in Romania maize are cultivated on approximate 2.5 million hectares. Lack of seed treatment alternatives of the spring crops can have negative impact in Romanian agriculture in next years (Ionel I.I., 2014). In last years, at NARDI Fundulea it has made several researches for finding possible alternatives at neonicotinoid seed treatments, in climatic conditions of south-east of the Romania (Georgescu E. *et al*, 2014b, 2015, 2016). The results of this studies demonstrate that there weren't finding chemical alternatives at neonicotinoids seed treatment at maize crop. In this paper authors collective present preliminary results of a three years study concerning effectiveness of two active ingredients, neem oil and spinosad, for controlling of maize leaf weevil (*Tanymecus dilaticollis*) at maize plants. The aim of this study is to determine if these two active ingredients, used in biological control, can be a real solution for chemical seed treatment at maize crop.

MATERIAL AND METHOD

The field trials were carried out at Plant and Environment Protection Collective from National Agricultural Research and Development Institute (NARDI) Fundulea, Calarasi County (latitude: 44,46; longitude: 26,32; alt.: 68 m), Romania, in period 2016-2018.

In this experiment it has tested neem oil and spinosad active ingredients, both at seed treatment and foliar application. These two active ingredients were compared with imidacloprid used for seed treatment. For seed treatment, the dose of the three active ingredients, from this study was 10.0 l/to. At variants with single foliar spraying (without seed treatment), the dose of neem oil and spionsad was 0.15 l/ha.

Experimental plots were arranged according randomized blocks scheme. Plot length was of 10 m and plot with was of 4.2 m, as result plot area was 42 m². In all years' maize was sowing in May.

Attack intensity is evaluated when the maize plants arrive in four leaf stage (BBCH 14), according a scale from 1 to 9, elaborated and improved by Paulian F. (1972), 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 leafs edge; note 4-plants with leafs chafed in proportion of 25 %; note 5-plants with leafs chafed in proportion of 50 %; note 6-plants with leafs chafed in proportion of 75 %; note 7-plants with leafs chafed almost at the level of the stem; note 8-plants with leafs 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 plant 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. Between 2016 and 2018 it has monitoring air temperature and rainfalls occurred from summer period (April-May).

Data from the field assessments was **statistical analyzed** using Newman-Keuls test.

Table 1

Temperatures registered at NARDI Fundulea, during April-May 2016-2018

Year	**Temperature (°C)**				**Deviation from average temperature registered in April (°C)**	**Deviation from average temperature registered in May (°C)**
	April		**May**			
	Curent year	Multiyear average	Curent year	Multiyear average		
2016	14.0	**11.1**	16.1	**16.9**	**+2.9**	**-0.8**
2017	10.6		16.8		**-0.5**	**-0.1**
2018	15.8		19.4		**+4.7**	**+2.5**

Table 2

Rainfalls registered at NARDI Fundulea, during April-May 2016-2018

Year	**Rainfalls (mm)**				**Deviation from average temperature registered in April (mm)**	**Deviation from average temperature registered in May (mm)**
	April		**May**			
	Curent year	Multiyear average	Curent year	Multiyear average		
2016	73.7	**59.0**	81.2	**72.3**	+14,7	+8.9
2017	73.4		81.8		+14,4	+9.5
2018	3.8		50.6		**-55.2**	**-21.7**

Table 3

Attack intensity of *T. dilaticollis* at maize plants, in field conditions, at NARDI Fundulea

Nr. crt.	**Active ingredient**	**Rate**	**Attack intensity (1-9)**					
			2016		**2017**		**2018**	
1	control (untreated)	—	5.91	a	5.59	a	4.61	a
2	imidacloprid seed treatment	10.0 l/to	3.70	b	3.63	b	3.45	b
3	neem oil seed treatment	10.0 l/to	5.90	a	5.57	a	4.52	a
4	neem oil foliar treatment	0.15 l/ha	5.83	a	5.52	a	4.58	a
5	spinosad seed treatment	10.0 l/to	5.50	a	5.18	a	4.60	a
6	spinosad foliar treatment	0.15 l/ha	6.12	a	5.32	a	4.59	a
LSD P=0.05			0.534		0.033		0.653	
Standard deviation (SD)			0.355		0.022		0.433	
Variation coefficient (C.V.)			6.460		2.820		3.580	

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

Table 4

Effectiveness of some insecticides used for maize seed treatment for controlling of *T. dilaticollis*, at NARDI Fundulea

Nr. crt.	**Active ingredient**	**Rate**	**Saved plant percent (%)**					
			2016		**2017**		**2018**	
1	control (untreated)	—	70.15	b	77.39	a	81.03	b
2	imidacloprid seed treatment	10.0 l/to	80.28	a	86.18	a	87.01	a
3	neem oil seed treatment	10.0 l/to	67.94	bc	78.49	a	81.51	b
4	neem oil foliar treatment	0.15 l/ha	67.50	bc	77.62	a	81.76	b
5	spinosad seed treatment	10.0 l/to	77.65	ab	81.09	a	82.05	b
6	spinosad foliar treatment	0.15 l/ha	57.94	c	79.60	a	81.26	b
LSD P=0.05			8.278		0.046		2.575	
Standard deviation (SD)			5.493		0.031		1.709	
Variation coefficient (C.V.)			7.820		1.610		2.620	

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

RESULTS AND DISCUSSIONS

Data from tables 1 and 2 show that climatic conditions registered at NARDI Fundulea, in April and May, were atypically. In 2016, average air temperature registered in April was higher than multiyear average and lower then multiyear average in May. In 2017, average air temperature was bellow multiyear average, both in April and May. In 2018, average air temperatures registered in April and May was higher than multiyear averages, with a positive deviation of +4.7 °C (April) and +2.7 °C (May). Rainfalls amount registered at meteorological station from NARDI Fundulea was higher than multiyear average, both in April and May, in 2016 and 2017. However, in 2018 climatic conditions from high period were different. In April it has registered only 3.8 mm comparative with multiyear average (59.0 mm). In May (2018) registered rainfalls amount was below multiyear average. From all three years presented in this study, 2018 was the most favorable for maize leaf weevil attack, because of high temperatures and drought.

Figure 1 **Experimental plots with seed treatment effectiveness assessments at NARDI Fundulea**

Analyzing data from table 3 it has ascertained that attack intensity of maize leaf weevil (*Tanymecus dilaticollis*) at maize untreated plants, from a scale from 1 to 9, was 5,91 in 2016, 5,59 in 2017 and 4,61 in 2018. The most of assessed maize untreated plants have leafs chaffed in proportion of 75 % in climatic conditions of the 2016 and between 50 and 75 % in climatic conditions of the year 2017. As result of higher rain amount from spring period, registered in 2016 and 2017, the most of the attacked maize plants has recovered after weevil's attack. The data obtained in conditions of the year 2018 were in contradictions with data from literature. Possible explication for lower pest attack, even if the climatic conditions for insects were very favorable is because of daily distributions of the rainfalls amount from May. The most of the rainfalls registered in this month, was registered from 13 to 19 May, when maize plants from this study were in first vegetation stages (BBCH 10-14). Because in this short period weather conditions weren't favorable for maize leaf weevils, the attack of this insects at maize plants, in experimental field of the NARDI Fundulea were lower comparative with 2016 and 2017, even if the overall climatic conditions from April and May (2018) were very favorable for *T. dilaticollis*.

In conditions of the year 2016, there weren't statistical differences between untreated variant and spinosad active ingredient used, both like seed treatment and foliar application. There weren't statistical differences between neem oil applied both like seed treatment and foliar application and untreated variant. Higher statistical difference was registered between variant treated with imidacloprid active ingredient and untreated variant ($p<.05$). The results were similar in next two years. Data from this study make in evidence that seed treatment with imidacloprid active ingredient provide satisfactory protection of the maize young plants, against weevils attack (*T. dilaticollis*) in different climatic conditions from spring period. The results concerning seed treatment with imidacloprid active ingredient from this study were in accordance with those obtained by Vasilescu S. *et al* (2005), Keszthelyi S. *et al*, (2008), Trotus E. *et al* (2011), Georgescu E. *et al* (2014, 2015, 2016).

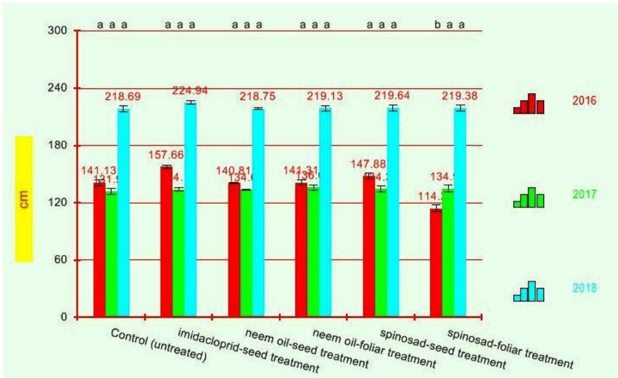

Figure 2 **Plants height at 50 days from emergence**

In conditions of the year 2016, saved plants percent was below 70 % in case of variants treated with neem oil, both like seed treatment and foliar application (*table* 4). Highest value of this parameter was registered in case of variant treated with imidacloprid while lowest value it has registered in case of variant with single foliar treatment with spinosad active ingredient (57,94

%). Highest statistical difference comparative with untreated variant (p<.05) was registered in case of variant treated with imidacloprid (seed treatment). In climatic conditions of the year 2017, saved plants percent presented higher values comparative with 2016. However, there weren't statistical differences between experimental variants (p<.05), even if the higher saved plants percent value it has registered in case of imidacloprid seed treatments. In conditions of the year 2018, saved plant percent ranged between 81.03 % in case of untreated variant and 87.01 % in case of variant treated with imidacloprid. There weren't statistical differences (p<.05) between untreated variant and variants treated with neem oil or spinosad active ingredients, both like seed treatment (10.0 l/to) and foliar application (0,15 kg/ha).

Figure 3 **Maize plant attacked by *T. dilaticollis***

Concerning at plant height, determined at 50 days from the plants emergence it has ascertained that in climatic conditions of the year 2016 highest value of this parameter it has registered in case of variant treated with imidacloprid active ingredient (*fig*. 2). In 2017, plants height at 50 days from plants emergence ranged between 131.99 cm (untreated variant) and 136.07 cm (neem oil-foliar application). However, there weren't statistical differences between variants, regarding this parameter (p<.05). In conditions of the year 2018, at experiental field from NARDI Fundulea it has registered highest values of plant height from all three studied year. At all experimental variants, at 50 days from plants emergence, plants height was higher than 218 cm! Possible explication for these values is both because of lower attack of maize leaf weevil in spring and higher rainfalls amount registered in June and first 10 days of the July.

CONCLUSIONS

In last three years, climatic conditions from spring period registered in south-east of the Romania were atypically.

The attack of *Tanymecus dilaticollis* at maize untreated plants at NARDI Fundulea was moderate in 2016, 2017 and lower in 2018.

In this study, oil neem and spinosad active ingredients applied both like seed and foliar treatment wasn't effective in protection of maize plants against *Tanymecus dilaticollis* attack.

Further studies are necessary, in more locations with higher pest pressure and different climatic conditions to elucidate this aspect.

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