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ACTUAL PROBLEMS CONCERNING PROTECTION OF THE WHEAT CROPS AGAINST CEREAL GROUND BEETLE (*Zabrus tenebrioides* Goeze) ATTACK IN SOUTH-EAST OF THE ROMANIA

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Abstract

Cereal ground beetle (Zabrus tenebrioides Goeze) represents one of the most important pests of wheat crop, in south-east of the Romania. Larva lives in soil and represents the most damaging stage of this pest. Higher attacks can occur in case of wheat monoculture or plants emerged from untreated seeds. High soil moisture and moderate temperatures are favorable conditions for Zabrus tenebrioides larva development and attack. In this paper, authors collective present results concerning testing effectiveness of the seed treatment with both, low and high doses of imidacloprid and mixture (imidacloprid+tebuconazole), in climatic conditions from south-east of the Romania, at NARDI Fundulea. Favorable conditions for pest attack it has registered in period October 2014-March 2015, when attacked plants percent at wheat emerged from untreated seeds was 46.16% and October 2015-March 2016, when attacked plants percent at wheat emerged from untreated seeds was 32.89%. In last years, during autumn, periods with higher rainfall amount occurred when wheat plants were in first vegetation stages, the most critical period of this crop for cereal ground beetle attack. In all of the years from this study, highest effectiveness in protection of wheat plants against attack of Zabrus tenebrioides larva were provided by imidacloprid active ingredient, in dose of 0.88 and 1.66 l/t. Also, imidacloprid+tebuconazole active ingredients provide good protection for wheat crops against this pest. In case of different climatic conditions, registered in last years, seed treatment assign stable protection of wheat crop and represent an effective method for control of Zabrus tenebrioides.

Key words*: wheat, ground beetle, damage, control*.

INTRODUCTION

With a surface higher then 2 million hectares, each year, wheat is the second crop cultivated in Romania, after maize (MADR data, 2016). Cereal ground beetle (*Zabrus tenebrioides* Goeze) represents one of the most important pests of wheat crop, in south and south-east of the country (Knechtel and Knechtel, 1909; Manolache et al., 1959, 1960; Paulian et al., 1959; 1965; Hulea et al., 1975; Barbulescu et al., 1985, 1988, 1995, 2001; Popov, 1975, 1985; Popov et al., 1996, 2004a). Also, this pest occurs in West Plane, Tarnava or Mures rivers valley (Rosca and Rada, 2009). Same authors mentioned that highest populations of this pest in Romania occur in Baragan Plane. In Europe this pest produce damage at wheat and barley crops, especially in countries around Black Sea (Romania, Bulgaria, Ukraine, South of Russia, Turkey) and Greece (Chenikalova et al., 2009). Also, *Zabrus tenebrioides* is spread in several countries from Western Europe such as: England, France, Germany, Italy (Bassett, 1978; Kreuz et Engelhardt, 1991, Nicosia et al., 1996; Jullien, 1999) or Central Europe such as Austria, Czech Republic or Slovakia (Cate, 1980; Martinez and Pillon, 1993; Oezder and Kivan, 1998). Larva lives in soil and represents the most damaging stage of this pest, for wheat crops (Manolache et al., 1963; Hulea et al., 1975; Kryazheva et al., 1989; Walczak, 2007). In the climatic conditions of Romania, the attack of *Zabrus tenebrioides* larva is very dangerous in autumn, when plants are in first vegetation stages (Manolache et al., 1963;

Popov, 2002). In case of higher attack occurred in autumn, wheat crops can be destroyed and farmers must sowing again (Popov, 1999 cited by Rosca and Rada, 2009). Attack occurred in spring, after tillering stage of wheat, are less harmful, generally one or two tillers are destroyed by larva, but plants survive (Hulea et al., 1975; Popov et al., 1996). According Popov et al. (2006), the late attack in spring, is less visible, because the plants have a high biomass, fact that camouflages the damage and ensures a better survival of the attacked plants. Same author mentioned that high soil moisture and moderate temperatures are favorable conditions for *Zabrus tenebrioides* larva development, as result attack of this pest at wheat crops can be high. Contrarily, in years with dry autumns, low humidity from soil represent unfavorable conditions for larva development, as result the attack occurs later, after the first rains, with no obvious damages. Popov et Barbulescu (2007) mentioned that in period 1950-1960, in south and south-east of the Romania it was recorded high pest density, ranged from 75000 to 100000 larva/ha. In first half of XX century, in some favorable years it has recorded more the 250000 ha with wheat destroyed by cereal corn beetle larva attack (Popov et al., 2010). Wheat monoculture favors *Zabrus tenebrioides* attack and the increasing of pest density from one year to another (Popov et al., 1983, 2004b). However, only crop rotation is not enough for wheat crop protection against cereal ground beetle (Popov et al., 2008). Along the time, at NARDI Fundulea (former ICCPT Fundulea) it has made several researches concerning chemical protection of the wheat crops against *Zabrus tenebrioides* attack (Popov et Barbulescu, 2007, Popov et al., 2010). First product synthesized in Romania for seed treatment was FB 7 (Paulian et al., 1965). This product has two active ingredients, linden for pest control and ethyl mercuric chloride for seed borne diseases. Popov (1985) mentioned that seed treatment with FB7 was generalized in Romania, in 8th decade of 20th century, when more then 1 million hectares were sowing with treated seeds. After ban of ethyl mercuric chloride active ingredient, product FB7 was replaced with Tirametox 90 PTS (Popov et al., 2007). After 2006, linden active ingredient was banned, because of higher toxicity for environment. As result, neonicothinoids insecticides remain available for seed treatment, with effectiveness higher then 90 % (Popov et al., 2010; Trotus et al., 2011). In a previous study, made in south of the Romania, Popov et al. (2010) mentioned that, between 2003 and 2007, the attack of *Zabrus tenebrioides* larva at wheat plants emerged from untreated seeds ranged from 9,8 to 17,0 % at NARDI Fundulea. Also, in same period, at ARDS Marculesti the attack ranged between 6,2 and 17,2 % while at ARDS Caracal the attack of larva, was 7,3 % in 2003 and 23 % in 2004. Unpublished reports and some articles published in journals for farmers make in evidence higher attack of *Zabrus tenebrioides* at wheat crops in last years (Georgescu, 2014; Georgescu et Risnoveanu, 2015). Possible reasons for increasing of the cereal ground beetle attack is lack of seed treatment, because of higher price of pesticides, wheat monoculture and climate changes (Kocmánková et al, 2010; Olesen et al., 2011; Lup et al., 2013). After EU directive 485/2013, from 1 December 2013, the use of three active ingredients for seed treatments of the spring crops and oilseed rape (imidacloprid, clothianidin and thiamethoxam) were restricted (Official Journal of the European Union, 2013). However, seed treatment for cereals sowed in autumn is not affected by this directive.

The aim of this study is testing effectiveness of the seed treatment with both, low and high doses of imidacloprid and mixture imidacloprid+tebuconazole, to control *Zabrus tenebrioides* attack in conditions of wheat monoculture, in south-east of the Romania.

MATERIALS AND METHODS

The researches were carried out at experimental field of the Plant Protection Collective, from National Agricultural Research Development Institute, Fundulea, Calarasi County, Romania (44° 30′ N, 24° 1′ E), starting from autumn of the year 2013 until spring of the year 2016. The experiments were arranged after randomised blocks designs. Each experimental variant have four repetitions. Experimental plots have 10 m length, 2 m width, as result plot surface was of 20 m^2. In all years of study, wheat was sowed in monoculture system, at the middle of the

October. It has tested four doses of imidacloprid (600 g/l) active ingredient and two doses of imidacloprid (233 g/l)+tebuconazole (13 g/l) mixture (Table 1).
The assessments concerning the attack of *Zabrus tenebrioides* it was made at the end of autumn (November) and beginning of spring (March). At each plot, on 10 row meter chosen randomly or in "stair" system, in central area of plot, it has assessed the number of emerged plants and the number of damaged plants. The attack of *Zabrus tenebrioides* is easy to recognize in the field, larva drag the plants in soil and chewed them, finally from attacked wheat plants remains at the soil surface, main nervures like a hemp flock (Figure 1). At each experimental variant it has calculated the effectiveness of seed treatment, comparative with control (untreated) variant.

Table 1. Active ingredients used in the field experiments concerning wheat seed treatment effectiveness against *Zabrus tenebrioides* Goeze

Variant	Active ingredient	Dose (kg/t)
1	control (untreated)	—
2	imidacloprid (600 g/l)	0.58
3	imidacloprid (600 g/l)	0.70
4	imidacloprid (600 g/l)	0.88
5	imidacloprid (600 g/l)	1.66
6	Imidacloprid (233 g/l)+tebunconazole (13 g/l)	2.00
7	Imidacloprid (233 g/l)+tebunconazole (13 g/l)	2.25

Meteorological data (average air temperatures and daily rainfalls) were provided by meteorological station of NARDI Fundulea, each year. From this study it has taken in considerations data from the beginning of October until end of March, that represent the most critical period for attack of cereal ground beetle larva at wheat crop.
The data were **statistical analyzed** through the analysis of variance method by using of the Microsoft Excel 2003 and ARM 8.5 software.

RESULTS AND DISCUSSIONS

Climatic conditions during this experiment were variable. Concerning rainfall amount, registered in October and November, period that coincide with first vegetation stages of wheat plants, data from the meteorological station of NARDI Fundulea show that highest amount of rainfalls were registered in November 2015 (Figure 2).

Figure 1. Typically symptoms of *Zabrus tenebrioides* larva attack, at wheat plants (ARDS Braila, 2015)

In 2014, both in October and November, rainfalls amount were higher then multiyear average, while in October 2013, rainfalls amount were with 20,8 mm over multiyear average. Contrarily, in November 2013 it has registered low rainfall amount, below multiyear average. However, analyzing daily distributions of the rainfalls at NARDI Fundulea, it has ascertained that more then 80 % of the rainfalls from October 2013 it has registered only in one day, at the first day of this month. After 1 October 2013, until the end of autumn, it has registered low rainfalls amount. However sol moisture was high.

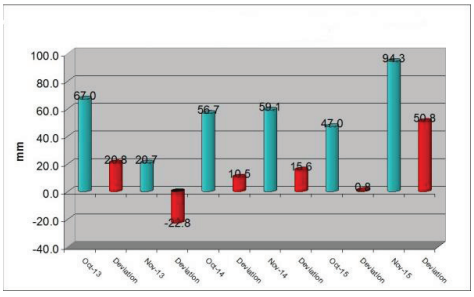

Figure 2. Rainfalls amount registered in October and November, at NARDI Fundulea, period 2013-2015

Average air temperature was highest then multiyear average in November 2013 and November 2015 (Figure 3). In rest of the period from autumn (years 2013-2015), deviations from multiyear average was low.
Data from table 2 show highest attack of *Zabrus tenebrioides* larva at wheat untreated

plants in season 2014-2015 (I=43.16 %) and season 2015-2016 (I= 32.89%). Also, in season 2013-2014 (autumn of 2013-spring of 2014) it has ascertained that more then 20 % of the plants from experimental variant without treated seeds were attacked. In last years, the attack of cereal ground beetle larva at untreated wheat plants, registered at NARDI Fundulea, was highest then 10 years ago.

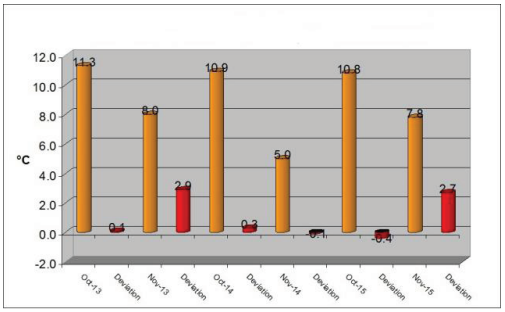

Figure 3. Temperatures registered in October and November, at NARDI Fundulea, period 2013-2015

A possible explication for this is because in last years, during autumn, periods with higher rainfall amount occurred when wheat plants are in first vegetation stages, the most critical period of this crop for *Zabrus tenebrioides* attack. Data from literature demonstrate that attack of larva can continue during winter season too, if temperature at soil surface is higher then +3 °C, without snow (Manolache et al., 1963; Hulea et al., 1975; Bassett, 1978; Popov, 2002; Rosca et Rada, 2009). At low temperatures and snowfall, the attack stops.

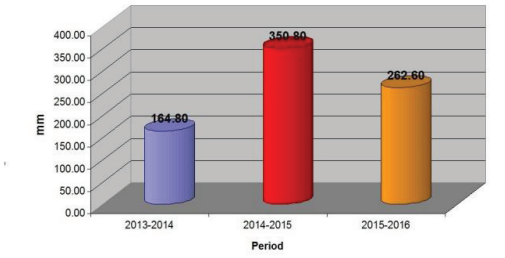

Figure 4. Rainfalls amount registered in October and March, at NARDI Fundulea, period 2013-2016

Total rainfall amount registered from October until March was highest in season 2014-2015 (Figure 4). Also, in season 2015-2016, between October and March it has registered 262,6 mm of rains. Deeper analyze of meteorological data from NARDI Fundulea, make in evidence that rainfalls amount from December 2014 was 119.4 mm comparative with multiyear average for this month, of 44.1 mm. Highest amount of rainfalls amount registered in October, November and December, 2014, determined high soil moisture, that represent favorable conditions for larva development. This is a possible explication for high value of *Zabrus tenebrioides* attack at wheat untreated plants, sowed in monoculture system. In last years, at NARDI Fundulea there was positive correlation between rainfalls amount, registered from autumn (October) until beginning of the spring (March) and attack of cereal ground beetle larva at wheat untreated plants (Figure 5).

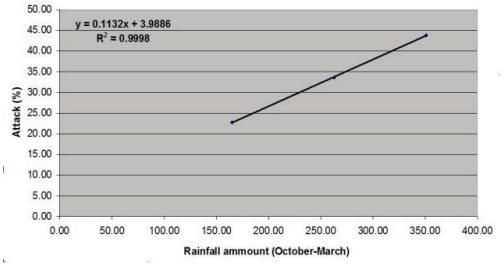

Figure 5. Relations between rainfalls amount and attack of *Zabrus tenebrioides* larva at untreated wheat plants (2013- 2016)

Long term studies on precipitations evolution show a decreasing trend, in countries from Central and South-East Europe, including Romania (Bozo, 2011). Same author mentioned that, sometime, increasing precipitations is visible as a shorter term tendency. This situation occurred in last years, in autumn period, at NARDI Fundulea. According Gregory et al. (2009), many pests and diseases can be favoured by climate changes. Same author mentioned that the interactions between crops and pests are complex and poorly understood in the context of new climatic conditions. Further study are necessary to determinate influence of the climate changes from both, autumn and winter period, concerning attack of *Zabrus tenebrioides* at wheat plants, in south and south-east of the Romania.

Analyzing data from Table 2, it can be ascertained that the attack of the *Zabrus tenebrioides* at treated variants was higher in case of lower dose of imidacloprid (0.58 l/t) in all studied years. Lowest percentage of attacked wheat plants, it has registered in case of higher dose of imidacloprid used in this experiment (1.66 l/t), and mixture between imidacloprid and tebuconazole. In all of these cases, the attack was below 1 %.

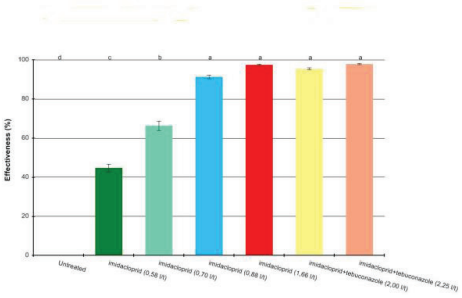

Figure 6. Effectiveness of seed treatment against *Zabrus tenebrioides* (2013-2014)

In autumn of 2013 and beginning of the spring, 2014, highest effectiveness in protection of wheat plants, against cereal ground beetle larva attack was provided in case of both, highest dose of imidacloprid and mixture between imidacloprid and tebunconazole (E = 97.48 % respectively 97.88 %).

The differences between these variants and control (untreated) variant were significant ($P<0.05$). Also, high effectiveness it has registered in case of lower dose of mixture (imidacloprid+tebuconazole) used in this experiment, and imidacloprid dose of 0.88 l/t (Figure 6).

In season 2014-2015, at lowest dose of imidacloprid used in this experiment (0.58 l/t) the attacked wheat percent was 22.13 %. Also, at variant treated with imidacloprid in dose of 0.70 l/t, the attack presented high values. Contrary, at highest dose of imidacloprid from this experience (1.66 l/ha), the attack of *Zabrus tenebrioides* was low (Figure 7).

In case of high pest pressure from autumn period of 2014 and beginning of the spring 2015, imidacloprid active ingredient in dose of 1.66 l/t and both doses of mixture between imidacloprid and tebunocazole, provide high effectiveness in protection of wheat plants, in first vegetation stages against *Zabrus tenebrioides* larva attack.

Table 2. Attack frequency (%) of *Zabrus tenebrioides* Goeze, at wheat plants, in experimental field of Plant Protection Collective, NARDI Fundulea (2013-2016)

Active ingredient	Dose (l/t)	Attacked plants percent (%)		
		2013-2014	2014-2015	2015-2016
control (untreated)	—	22.51**a**	43.16**a**	32.89**a**
imidacloprid (600 g/l)	0.58	13.29**b**	22.13**b**	17.01**b**
imidacloprid (600 g/l)	0.70	7.44**c**	11.68**c**	9.51**c**
imidacloprid (600 g/l)	0.88	1.91**b**	2.96**d**	2.70**d**
imidacloprid (600 g/l)	1.66	0.57**f**	0.29**f**	0.30**f**
imidacloprid (233 g/l)+tebunconazole (13 g/l)	2.00	0.99**e**	0.91**e**	0.82**e**
imidacloprid (233 g/l)+tebunconazole (13 g/l)	2.25	0.47**f**	0.73**e**	0.40**f**
LSD P=.05		0.083	0.077	0.098t
Standard deviation (SD)		0.056	0.052	0.066t
Coefficient of variation (CV)		8.6	6.82	9.45t
Replicate F		3.308	0.455	3.739
Replicate Prob. (F)		0.0438	0.7171	0.0300
Treatment F		303.379	546.317	299.766
Treatment Prob. (F)		0.0001	0.0001	0.0001

Means followed by same letter do not significantly differ (P=0.05, Student-Newman-Keuls)

Also, effectiveness of the imidacloprid active ingredient, in dose of 0.88 l/t was higher then 93 %. Similar like in previous season, higher pest pressure was registered in season 2015-2016. The attack of *Zabrus tenebrioides* larva at wheat untreated plants was higher then 30 %.

At lowest dose of imidacloprid active ingredient, used in this experiment (0.58 l/t), the attacked wheat plants percent by larva of *Zabrus tenebrioides* was 17.01 % while at higher dose of imidacloprid (1.66 l/t) the attack was 0.3 %. In case of both doses of mixture

(imidacloprid+tebuconazole), the attacked plants percent has low values (I = 0.82 % respectively 0.40 %).

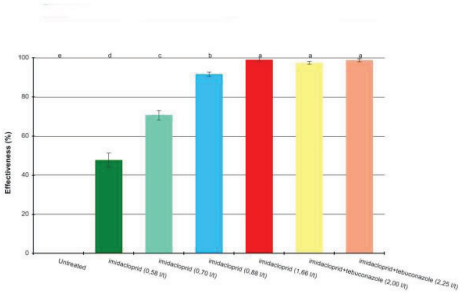

Figure 8. Effectiveness of seed treatment against *Zabrus tenebrioides* (2015-2016)

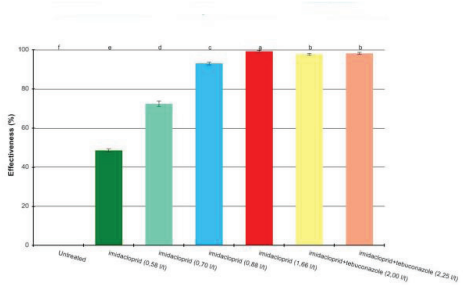

Figure 7. Effectiveness of seed treatment against *Zabrus tenebrioides* (2014-2015)

In autumn of the 2015 and beginning of the spring, 2016, highest effectiveness in protection of wheat plants, in first vegetation stages, was provided by imidacloprid, in dose of 1.66 l/t, and mixture between imidacloprid and tebuconazole, in doses of 2.00 and 2.25 l/t (Figure 8).

The differences between these variants and control (untreated) variant were statistically assigned. Also, in case of variant treated with imidacloprid, in dose of 0.88 l/t, the effectiveness was higher then 93 %.

Contrary, at variant treated with lowest dose of imidacloprid, the effectiveness of the seed treatment was lower.

Data from this experiment demonstrate that seed treatment with imidacloprid active ingredient in dose of 0.88 and 1.66 l/t and mixture between imidacloprid and tebuconazole active ingredients, in dose of 2.00 and 2.25 l/t, provide good protection of wheat plants, from emergence until tillering stage against attack of *Zabrus tenebrioides* larva.

Figure 9. Cereal ground beetle (*Zabrus tenebrioides* Geoze) larva, at wheat crop (NARDI Fundulea, 2015)

Figure 10. Attack of cereal ground beetle (*Zabrus tenebrioides* Geoze) larva, at wheat untreated crop, sowed in monoculture system (ARDS Braila, 2015)

Also, in case of different climatic conditions, registered in last years, seed treatment assign stable protection of wheat crops, even in monoculture system. At same conclusion arrive Popov et al. (2007, 2008, 2010) and Trotus et al. (2011).

In case of favorable climate conditions for *Zabrus tenebrioides* larva, looses at wheat untreated crops can be higher then 40 % (Figures 9 and 10).

CONCLUSIONS

In last years, climatic conditions registered in autumn and beginning of the spring at NARDI Fundule was favorable for *Zabrus tenebrioides* attack. Attacked wheat plants percent by *Zabrus tenebrioides* larva was 43.16 % in

season 2014-2015, 32.89% in season 2015-2016 and 22.51% in season 2013-2014.

In all of three years of this study, in different climatic conditions, seed treatment with imidacloprid active ingredient, in dose of 0.88 and 1.66 l/t and mixture between imidacloprid and tebuconazole, provide effective protection of wheat plants, in first vegetation stages, against *Zabrus tenebrioides* attack.

Further studies are necessary to evaluate the impact of climate changes concerning *Zabrus tenebrioides* attack in south-east of the Romania.

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