RESULTS CONCERNING TESTING OF THE SPIROTETRAMAT ACTIVE INGREDIENT FOR CONTROLLING OF TWO SPOTTED SPIDER MITE (*TETRANYCHUS URTICAE* KOCH) AT SOYBEAN CROP IN SOUTH-EAST OF THE ROMANIA

Emil GEORGESCU[1], Lidia CANĂ[1], Luxita RASNOVEANU[2]

emilgeorgescu2013@gmail.com

Abstract

Two spotted spider mite (*Tetranychus urticae* Koch) is one of the most dangerous pest of soybean crops in Romania. In case of lack of the control measures, damages produced by this pest can arrive at 70% or, in some cases, at 100%. High temperatures and, especially, drought from summer period represent favorable conditions for two spotted spider mite. Chemical control is the most effective method to control *T. urticae* at soybean crop. However in Romania there are low numbers of registered active ingredients for control of this pest. In period 2014-2016, at NARDI Fundulea there were tested three doses of spirotetramat active ingredients for two spotted spider mite control in soybean crop. Average air temperatures registered in July and August, between 2014 and 2016, was higher then multiyear average. Also, rainfalls amount registered in July was below multiyear average while rainfalls amount registered in August 2014 were lower then multiyear average, higher in August 2015 and close to normal in August 2016. Result of this experiment show that in the climatic conditions from NARDI Fundulea, spirotetramat active ingredient, applied like vegetation treatment, in dose of 0.75 p.c./ha have effectiveness higher then 99 % in control of two spotted spider mite at soybean crops, between 2014 and 2016, while spirotetramat in dose of 0.60 p.c./ha have effectiveness higher then 98 %. This doses of spirotetramat have similar effectiveness with hexithiazox active ingredient, applied in dose of 0.40 kg/ha. In last years, climatic conditions from summer period, in south-east of the Romania were favorable for two spotted spider mite attack.

Key words: soybean, pest, control, drought, summer

In the last years, areas cultivated with soybean in Romania start increasing again, as result of support measures applied in EU for production increasing of this crop and decreasing quantities of the soybean imports (Lup A. *et al*, 2013; Mc Farlane I. and O'Conor E.A., 2014; Boerema A. *et al*, 2016). According Eurostat (2016) and MADR data (2016), Romania occupy second place in EU, after Italy, with a soybean area of 128100 ha in 2015 and 127000 in 2016. The main reason for increasing of the soybean cultivated area in Romania was higher subsidies amount for the farmers. As result, in last years, the profitability of this crop increasing (Otiman P.I., 2013; Soare E. *et al*, 2014; Dima D.C., 2015). According Roman G.V. *et al*, (2016) soybean has more advantages such as: good previous plant for autumn wheat or barley crops, improving of the nitrogen content from the soil because of symbioses with bacteria from *Rhizobium* genus. Draught, weeds, diseases or pest attack represent constrains for the soybean crops, both in Europe and Romania (Dornbos D.L. and Mullen R.E., 1992; Haile F.Z. *et al*, 1998; Liu F. *et al*, 2003; Purcell L.C. *et al*, 2003; Sinclair T.R. *et al*, 2007; Balaj I. *et al*, 2012; Suciu L. *et al*, 2012; Brejea E., 2014; Lombardi A.R. *et al*, 2015; Rusu T. and Moraru P.I., 2015). In the climatic conditions of the Romania, the main pests of the soybean crop are two spotted spider mite (*Tetranychus urticae* Koch), lima-bean pod borer (*Etiela zinkenella* Tr.) or wireworms (*Agriotes* spp.)(Paulian F. *et al*, 1977; Barbulescu A. *et al*, 1993, 1997, 2001; Popov C. *et al*, 2002, 2007; Popov C. and Barculescu A., 2007; Muresanu F. *et al*, 2014; Trotus E. *et al*, 2014a). In some years, pests such as painted lady (*Vanessa cardui* L.), turnip moth (*Agrotis segetum* D&S) and silver Y (*Autographa gamma* L) can produce damages at soybean crops in Transylvania or central part of the Moldavia (Ivas A. and Muresanu F., 2013; Trotus E. *et al*, 2014b). Two spotted spider mite (*Tetranychus urticae* Koch) is the most dangerous pest of this crop (Perju T. *et al*, 2001; Rosca I. and Rada I., 2009; Jinga V. and Lupu C., 2014). Same authors

[1] NARDI, Fundulea

[2] ARDS, Braila and „Dunarea de Jos" University, Galati, Faculty of Engineering and Agronomy, Braila.

mentioned that in the climatic conditions of our country, *T. urticae* present 5-6 generations per year and the most damaging for soybean crops are attack of the generations III and IV (July-August). According Trotus E. et al, (2014b) in some years, in Central part of the Moldavia, Vth generation of two spotted spider mite can produce yield losses at soybean crops. Average air temperature and draught represent the most favorable conditions for pest development (Rosca I. and Rada I., 2009; Tehri K. *et al*, 2014). Researches made at NARDI Fundulea, make in evidence that draught conditions from south-east of the Romania, registered in summer period, between July and August, favor *T. urticae* attack at soybean crops cultivated in this region (Popov C. *et al*, 2006). Average soybean yield losses because of two spotted spider mite attack, ranged from 3 to 21 %, but in case of higher attack, yield losses can arrive at 70% and, in some cases, at 100 % (Paulian F. *et al*, 1977; Perju T. *et al*, 2001; Popov C. and Barbulescu A., 2007; Muresanu F., 2014). In Romania, the most effective method to control this pest in soybean crops is chemical treatments, in vegetation period (Popov C. and Barculescu A., 2007; Rosca I. and Rada I., 2009; Muresanu F. *et al*, 2014; Trotus E. *et al*, 2014a). Several researches from Europe, United States or Australia make in evidence that two spotted spider mite (*T. urticae*) develop resistance at 91 active ingredients from different chemical class (Herron G.A. and Rophail J., 1998; Sato M.E. *et al*, 2005; Tirrelo P. *et al*, 2012; Sparks T.C. and Nauem R., 2015; Van Leeuwen T. *et al*, 2015). A possible reason for this pesticides resistance is higher number of the generations per year, higher number of host plants, higher frequency of genetic mutations and inadequate chemical treatments to control this pest in field or greenhouse conditions (Kim Y.J. *et al*, 2006; Van Leeuwen T. et al, 2010; Khajehali J. *et al*, 2011). No pesticide resistance at two spotted spider mite was reported in Romania. However in the last 20 years, the number of the active ingredients used for chemical control of *T. urticae* was decreasing (Rosca I. *et al*, 2011). Same author mentioned that low number of active ingredients used in our country, for control of this pest increasing the risks of pesticide resistance phenomenon appearance. In present only 6 active ingredients are authorized for two spotted spider mite chemical control, at all crops, in Romania (Codex, 2016). Because of soybean area increasing and low numbers of active ingredients available on the market, new researches are necessary for finding of the new alternatives for chemical control of two spotted spider mite, in the climatic conditions of the Romania.

MATERIAL AND METHOD

The experience 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 2014-2016. Experimental plots were arranged according randomized blocks scheme. Plot length was of 10 m and plot with was of 2 m, as result plot area was 20 m^2. Vegetation treatments were made in July, when two spot spider mite (*T. urticae*) density was higher then 5 mottle/leaf. Assessments were made at 2, 7 and 14 days after applying of the treatment. With a magnify glass (x10) it has made observations at 50 soybean leafs, chosen randomly from each plot. It has determined total number of *T. urticae* mobile forms (nymphs and adults). Also it has determined pest density before the treatment. The effectiveness of the treatments was calculated according Abbot formula (*figure 1*).

$$Effectiveness = (1 - \frac{T}{T_0}) * 100$$

Figure 1. Effectiveness of the treatments, according Abbot formula (1925). T_0-number of motile before treatment; T-number of motile afthe the treatment.

In this experiment it has tested three doses of spirotetramat active ingredient (0.45; 0.60 and 0.75 p.c./ha) and hexithiazox active ingredient (0.40 kg p.c./ha).

Meteorological data was provided by Meteo station of the NARDI Fundulea. Between 2014 and 2016 it has monitoring air temperature and rainfalls occurred from summer period (July-August). Data from the field assessments was **statistical analyzed** using Newman-Keuls test.

RESULTS AND DISCUSSIONS

Data from table 1 show that average air temperature registered in July, at NARDI Fundulea, was higher then multiyear average in all studied years. Highest deviation from the average was registered in 2015 (+2.6 °C). Also, between 2014 and 2016, average air temperature registered in August was highest then multiyear average. Similar with July, in August 2015 it has registered highest difference of the average air temperature comparative with multiyear average, from all years taken in study (+2.0 °C). The temperature evolution from summer period was favorable for evolution of two spotted spider mite, at NARDI Fundulea. All deviations from the normal were positive, both in July and August.

Analyzing data from table 2 it has ascertained that, at NARDI Fundulea, average

rainfalls occurred in July were below multiyear average in all three years taken in this study. Maximum negative deviation from the normal it has registered in July, 2016 (-40.2 mm). Rainfalls amount registered in August at NARDI Fundulea was bellow multiyear average in 2014 (-25.3 mm), over multiyear average in 2015 (+41.8) and close to normal values in 2016. In last years climatic conditions from south-east of the Romania was characterized through higher average air temperature and draught. Data from the literature suggest that climate changes can have negative impact on agriculture, such as increased incidents of heat waves and droughts for the countries with continental climate, including Romania (Olesen J.E. et al, 2011).

Concerning evolution of the *T. urticae* populations, in soybean crop from experimental field of the NARDI Fundulea, in the climatic conditions of the year 2014, pest density was higher then 5 motile/leaf in 30 July, when it has effectuated vegetation treatments (*table 3)*. At untreated variant it has noticed slight decreasing of the two spotted spider mite populations at 7 days from starting of the assessments followed by slight increasing of pest density after beginning of this experiment. Data from table 3 show that at 2 days from vegetations treatment at variants treated with spirotetramat active ingredient, the density of *T. urticae* start decreasing at all three doses. Similar situation occurred in case of variant treated with hexythiazox active ingredient. At 7 days from vegetation treatment, pest density ranged from 0.25 motile/leaf in case of higher dose of spirotetramat and 0.50 motile/leaf in case of lower dose of spirotetramat. In case of variant treated with hexithiazox active ingredient, at 7 days from treatment it has registered highest statistical differences comparative with control variant. At 2 and 7 days from treatments, highest effectiveness it has registered in case of hexithiazox active ingredient. In case of spirotetramat active ingredient, at 7 days from treatments, effectiveness was higher then 92 % at all three doses (*figure 2*).

Table 1

Temperatures registered at NARDI Fundulea, during July-August 2014-2016

Year	Temperature (°C)				Deviation from average temperature registered in July (°C)	Deviation from average temperature registered in August (°C)
	July	August	July	August		
	Curent year	Multiyear average	Curent year	Multiyear average		
2014	23.0	22.5	23.8	21.9	**+0.5**	**+1.9**
2015	25.1		23.9		**+2.6**	**+2.0**
2016	24.1		23.4		**+1.6**	**+1.5**

Table 2

Rainfalls registered at NARDI Fundulea, during July-August 2014-2016

Year	Rainfalls (mm)				Deviation from average temperature registered in July (mm)	Deviation from average temperature registered in August (mm)
	July	August	July	August		
	Curent year	Multiyear average	Curent year	Multiyear average		
2014	52.1	71.6	27.3	52.6	-19,5	-25,3
2015	36.8		94.4		-34,8	+41,8
2016	31.3		64.6		**-40.2**	**+12.0**

Table 3

Mottle density of the two spotted spider mite (*T. urticae*), at NARDI Fundulea, in 2014

Nr. crt.	Active ingredient	Rate (l, kg/t)	Mottle number/leaf							
			T0 30 July	T1 1 August		T2 8 August		T3 18 August		
1	Control (untreated)	—	6.80	6.58	a	6.63	a	6.70	a	
2	spirotetramat (100 g/l)	0.45	5.88	3.83	b	0.50	b	0.08	b	
3	spirotetramat (100 g/l)	0.60	6.45	3.08	b	0.38	bc	0.05	b	
4	spirotetramat (100 g/l)	0.75	5.83	2.80	b	0.25	cd	0	b	
5	hexythiazox (10 %)	0.40	6.68	2.30	b	0.15	d	0	b	
LSD P=0.05				1.14		0.61		0.99		
Standard deviation (SD)				0.74		0.40		0.64		
Variation coefficient (C.V.)				19.78		17.20		18.13		

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

Table 4

Mottle density of the two spotted spider mite (*T. urticae*), at NARDI Fundulea, in 2015

Nr. crt.	Active ingredient	Rate (l, kg/t)	Mottle number/leaf							
			T0 15 July	T1 17 July		T2 22 July		T3 29 July	
1	Control (untreated)	—	6.80	8.65	a	9.00	a	8.43	a
2	spirotetramat (100 g/l)	0.45	7.15	3.88	b	1.10	b	0.23	b
3	spirotetramat (100 g/l)	0.60	6.63	3.15	b	0.30	c	0.08	bc
4	spirotetramat (100 g/l)	0.75	7.10	2.75	b	0.13	c	0	c
5	hexythiazox (10 %)	0.40	7.10	2.18	b	0.08	c	0	c
LSD P=0.05				1.87		1.57		1.23	
Standard deviation (SD)				1.21		1.02		0.80	
Variation coefficient (C.V.)				20.73		17.20		16.79	

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

Table 5

Mottle density of the two spotted spider mite (*T. urticae*), at NARDI Fundulea, in 2016

Nr. crt.	Active ingredient	Rate (l, kg/t)	Mottle number/leaf						
			T0 20 July	T1 22 July		T2 27 July		T3 3 August	
1	Control (untreated)	—	11.00	15.48	a	14.98	a	10.35	a
2	spirotetramat (100 g/l)	0.45	11.40	5.93	b	2.10	b	0.60	b
3	spirotetramat (100 g/l)	0.60	11.90	5.18	b	1.10	c	0.18	c
4	spirotetramat (100 g/l)	0.75	12.35	3.88	c	0.30	d	0	d
5	hexythiazox (10 %)	0.40	12.40	2.60	c	0.13	e	0	d
LSD P=0.05				1.00		0.48		1.36	
Standard deviation (SD)				0.63		0.30		0.88	
Variation coefficient (C.V.)				8.64		7.09		16.62	

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

At 14 days from the treatment, in case of variant treated with hexithiazox the effectiveness was 100% while at variants treated with spirotetramat in dose of 0.60 and 0.75 l p.c./ha, the effectiveness was higher then 99 %. There weren't statistical differences between treated variants concerning effectiveness in control of two spotted spider mite, at 2 weeks from vegetation treatments.

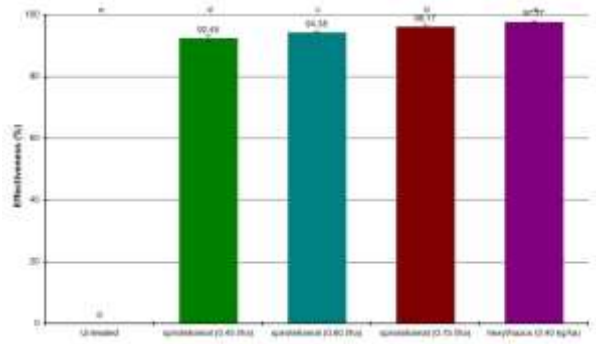

Figure 2 **Effectiveness of some active ingredients used for two spotted spider mite at soybean crop, at 7 days from treatment, in 2014**

In climatic conditions of the year 2015, at NARDI Fundulea soybean experimental field, pest density was higher then 5 motile/leaf on 15 July when it has effectuated vegetation treatments. At untreated variant pest density arrive at 9.0 motile/leaf at 22 July after that it has registered slight decreasing of the two spotted spider mite populations (*table 4*).

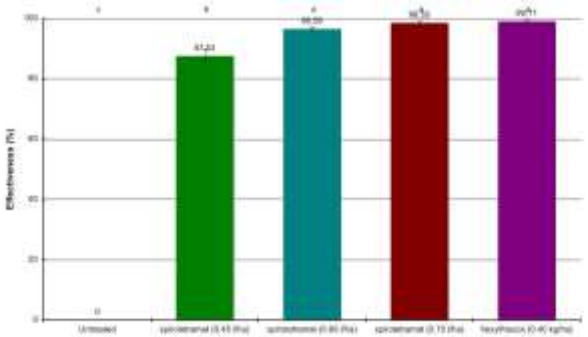

Figure 3 **Effectiveness of some active ingredients used for two spotted spider mite at soybean crop, at 7 days from treatment, in 2015**

At 2 days from the treatments highest effectiveness was registered in case of hexithiazox active ingredient and highest dose of spirotetramat active ingredient. At 7 days from the treatments in case of the variant treated with spirotetramat in dose of 0.60 l p.c./ha, effectiveness was 96.58 % while at higher dose of spirotetramat the effectiveness was 98.55 %. In case of hexithiazox active ingredient the effectiveness was higher then 99 % at 7 days from treatment (*figure 3*). At two weeks from the treatments there weren't statistical differences between last two doses of spirotetramat (0.60 and 0.75 l p.c./ha) and hexithiazox (0.40 kg p.c./ha).

Highest pest density was registered in conditions of the year 2016. Vegetation treatment it has effectuated at 20 July when it has registered 11.40 motile/leaf at untreated variant (*table 5*). Maximum pest density at control variant it has registered at 22 July (15.48 motile/leaf).

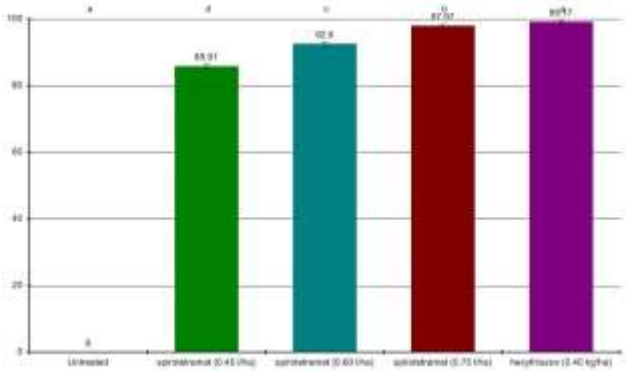

Figure 4 **Effectiveness of some active ingredients used for two spotted spider mite at soybean crop, at 7 days from treatment, in 2016**

At 7 days from the treatments, highest effectiveness it has registered in case of hexithiazox active ingredient and higher dose of spirotetramat (*figure 4*). At two weeks from the treatments there weren't statistical differences between spirotetramat active ingredient in dose of 0.60 and 0.75 l p.c./ha and hexithiazox active ingredient in dose of 0.40 kg p.c./ha.

CONCLUSIONS

Climatic changes from the last years can be favorable for two spotted spider mite (*Tetranychus urticae* Koch) attack at soybean crop in south-east of the Romania. However more studies are necessary, both in greenhouse and field conditions to clarify this aspect.

In 2016 it has registered highest density of two spotted spider mite (*Tetranychus urticae* Koch) at soybean untreated plants.

At NARDI Fundulea, in different climatic conditions from summer period, between 2014 and 2016, highest effectiveness in control of two spotted spider mite it has registered in case of spirotetramat active ingredient in dose of 0.60 and 0.75 l p.c./ha and hexithiazox active ingredient in dose of 0.40 kg p.c./ha. The two dose of spirotetramat has similar effectiveness.

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