

Effect of Abamectin on two-spotted spider mite and leaf miner flies in greenhouse cucumbers

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Effect of Abamectin 18 g l⁻¹ on two-spotted spider mite (*Tetranychus urticae* Koch.) and leaf miner flies (*Liriomyza strigata*, *Liriomyza bryoniae*) was studied in greenhouse cucumbers in 2005–2006. Efficiency of Abamectin 18 g l⁻¹ 0.12 % and 0.1 % against two-spotted spider mite was respectively 92.24–100 % and 82.8–99.2 %. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.075 % and 0.05 % against two-spotted spider mite was respectively 81.0–100 % and 72.4–94.0 %. Efficiency of Abamectin 18 g l⁻¹ 0.12 % and 0.1 % against leaf miner flies was respectively 63.6–80.3 % and 60.4–75.26 %. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.075 % and 0.05 % against leaf miner flies was respectively 35.9–54.4 % and 30.7–49.6 %. Azadirachtin A 10 g l⁻¹ and Spirodiclofen 240 g l⁻¹ were less effective against two-spotted spider mite and leaf miner flies.

Key words: Abamectin, Azadirachtin A, cucumber, *Liriomyza bryoniae*, *Liriomyza strigata*, Spirodiclofen, *Tetranychus urticae*.

Introduction. *Tetranychus urticae* is major pest on field crops, glasshouse crops, horticultural crops, ornamentals and fruit trees (Van de Vrie et al., 1972). It is one of the most serious pests in a number of agricultural systems; its outbreaks are often a consequence of repeated and non-selective pesticide applications, which enhance pesticide resistance (Helle, Sabelis, 1985). However, spider mite does not attack all plants to the same degree because of differences in nutritive and toxic constituents (Boom et al., 2003). Moreover, it can easily adapt to plant varieties that have been especially selected for resistance, as was shown for e. g. in tomato, broccoli and cucumber (Fry, 1989). Two-spotted spider mite feeds on leaves causing damage in chlorophyll and producing white spots that may become more or less coherent with time (Nachman, Zemek, 2002). Leafmining flies *Liriomyza strigata*, *Liriomyza bryoniae* are frequent species in Lithuanian glasshouses and around them (Ostrauskas et al., 2003, Ostrauskas et al., 2005). Adult leaf miner flies puncture plant leaves for feeding and oviposition. Larvae reduce the photosynthetic activity of the leaves by mining (Parrella et al., 1985). The decreased leaf productivity by *T. urticae* and leaf miner fly larvae feeding caused biomass reduction and altered the pattern of dry matter partitioning in the plant; damaged plants accumulated more dry matter in leaves,

and partitioning of dry matter to fruits was hindered (Park, Lee, 2005; Parrella et al., 1985).

Thus experiments performed in 2005–2006 were designed to clarify how active ingredient Abamectin affect two-spotted spider mite and leaf miner flies in cucumber.

Object, methods and conditions. The investigations were carried out in greenhouse cucumber during growing seasons of 2005–2006 in Lithuania as efficiency trials of Abamectin 18 g l⁻¹ against two-spotted mite and leaf miner flies. Greenhouse was covered with double film, the sides of greenhouse – with plastic. The general principles of investigations were in accord with EPPO standards (Anon, 1997).

The trial was carried out according to trial plan as follows (Table 1).

Table 1. Trial plan

1 lentelė. Bandyimo planas

Treatment Variantas	Trade name Registruoto preparato pavadinimas	Rate l per ha Norma l/ha (%)
Untreated Nepurkšta		
Abamectin 18 g l ⁻¹	Vertimex 1.8 EC	1.2 (0.12 %)
Abamectin 18 g l ⁻¹	Vertimex 1.8 EC	1.0 (0.1 %)
Abamectin 18 g l ⁻¹	Vertimex 1.8 EC	0.75 (0.075 %)
Abamectin 18 g l ⁻¹	Vertimex 1.8 EC	0.5 (0.05 %)
Azadirachtin A 10 g l ⁻¹ (standard / standartas)	NeemAzal-T/S	5.0 (0.5 %)
Spirodiclofen 240 g l ⁻¹ (standard / standartas)	Envidor 240 SC	0.5 (0.05 %)

The size of plot for tested plants was 10 m². Four replications were made in randomized block design. To determine efficiency of the examined insecticide 10 plants per plot were observed. After first observation leaves with leaf miner flies mines was removed. Mines were identified according to Pakalniškis et al. (2005). Pests were recorded as follows: 24 h before and 3, 7, 9 and 14 days after treatment. Biological efficiency of insecticides in pest control was presented as percentage of pest mortality. Statistical analysis of results was done.

Microclimate conditions in greenhouses at the time of treatments were favourable for insecticide applications (Table 2).

Efficacy of abamectin against two-spotted spider mites was calculated: $x = 100 \left(1 - \frac{A \cdot b}{B \cdot a}\right)$ (x – efficacy of insecticide, %, A – number of mites per leaf before spraying in untreated plot, B – number of mites per leaf before spraying in treated plot, a – number of mites per leaf after spraying in untreated plot, b – number of mites per leaf after spraying in treated plot).

The number of two-spotted spider mites and damaged leaves of leaf miner flies was compared among treatments in this study with single factor analysis of variance (ANOVA). Specific differences were identified with Duncan's multiple range test.

Table 2. Circumstances during application
2 lentelė. Sąlygos purškimo metu

Date of application Purškimo data	2005-07-20	2006-06-23
Code of plant growth stage during application (BBCH scale) Augalo augimo tarpsnis (pagal BBCH skalę)*	73–74	51–52
Temperature on the date of application Temperatūra (°C)	18	18
Relative air humidity on the date of application Santykinė oro drėgmė, %	81	80

* Growth stages are described according to BBCH scale

* Augalų augimo tarpiniai apibūdinami pagal BBCH skalę (Meier, 1997)

Results. Trial data shows that insecticide Abamectin 18 g l⁻¹, at rates of 0.12, 0.10, 0.075 % spraying solution was highly effective against two-spotted spider mites in 2005. There were not found any statistical differences of number of two-spotted spider mites between Abamectin 18 g l⁻¹ 0.12 % and Abamectin 18 g l⁻¹ 0.05 % other 3 and 7 days after treatments, but 9 days after 1st treatment it was found statistical differences between them (Table 3).

The number of two-spotted spider mites was significant less among Abamectin 18 g l⁻¹ 0.12 % and standards Azadirachtin A 10 g l⁻¹ 0.5 % 3 days after 1st treatment and Abamectin 18 g l⁻¹ 0.12 % and Azadirachtin A 10 g l⁻¹ and Spirodiclofen 240 g l⁻¹ 0.05 % 9 days after 1st treatment.

Table 3. Abundance of two-spotted spider mite (*Tetranychus urticae*) on cucumbers after first application

3 lentelė. Paprastųjų voratinklinių erkių (*Tetranychus urticae*) gausumas agurkuose po pirmojo purškimo

Babtai, 2005–2006

Treatments Variantas	Number of mites per leaf Erkių skaičius ant lapo			
	before treatment prieš purškimą	3 days after treatment praėjus 3 dienoms po purškimo	7 days after treatment praėjus 7 dienoms po purškimo	9 days after treatment praėjus 9 dienoms po purškimo
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
	2005			
Untreated Nepurkšta	40.25	58.0 c	62.5 b	59.25 e
Abamectin 0.12 %	31.75	4.5 a	1.0 a	0 a
Abamectin 0.10 %	34.25	10.0 ab	1.75 a	0.5 abc
Abamectin 0.075 %	33.75	11.0 ab	3.25 a	0 ab
Abamectin 0.05 %	28.50	12.75 ab	2.75 a	10.5 d
Azadirachtin A 0.5 %	27.0	21.0 b	6.50 a	10.0 cd
Spirodiclofen 0.05 %	31.50	23.5 b	5.75 a	9.25 bcd

Table 3 continued
3 lentelės tęsinys

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
2006				
Untreated	34.25	38.0 d	64.50 c	89.50 c
Nepurkšta				
Abamectin 0.12 %	37.00	2.50 a	0.75 a	1.25 a
Abamectin 0.10 %	36.50	4.0 ab	2.25 ab	2.0 a
Abamectin 0.075 %	33.75	8.25 abc	3.0 ab	5.0 ab
Abamectin 0.05 %	37.50	11.50 abc	4.25 ab	6.0 ab
Azadirachtin 0.5 %	38.0	17.75 c	12.25 b	8.75 b
Spirodiclofen 0.05 %	35.50	15.0 bc	7.50 ab	8.25 b

Note: Means followed by the same letter are not different significantly ($P = 0.05$) according to Duncan's multiple range test

Pastaba: Reikšmės, pažymėtos tomis pačiomis raidėmis, pagal Dunkano kriterijų ($P = 0,05$) iš esmės nesiskiria

The abundance of two-spotted spider mites in 2006 grew not so fast as in 2005. There were not found any statistical differences of the number of two-spotted spider mites between Abamectin 18 g l⁻¹ 0.12 % and Abamectin 18 g l⁻¹ (0.10, 0.075, 0.05%) 3, 5, 7 and 14 days after treatments. The number of two-spotted spider mites was significant less among Abamectin 18 g l⁻¹ (0.12, 0.1, 0.075, 0.05 %) and standards Azadirachtin A 10 g l⁻¹ 0.5 % and Spirodiclofen 240 g l⁻¹ 0.05 % 3 days after 1st treatment. There were found statistical differences of number among Abamectin 18 g l⁻¹ 0.12 % and standards Azadirachtin A 10 g l⁻¹ 0.5 % and Spirodiclofen 240 g l⁻¹ 0.05 % 3, 7 and 14 days after 1st treatment and Abamectin 0.1 % and Azadirachtin A 10 g l⁻¹ 14 days after 1st treatment.

Abamectin 18 g l⁻¹ 0.12 % was very efficient against two-spotted spider mite: 99.1, 98.4 and 100 % 5, 7 and 9 days after 1st treatment in 2005 (Table 4). An efficiency of Abamectin 18 g l⁻¹ (0.1 and 0.075 %) after 1st treatment against two-spotted spider mite was over 90 %. Effect of Abamectin 18 g l⁻¹ 0.05 % against mites was lower.

Abamectin 18 g l⁻¹ 0.12 % was very efficient against two-spotted spider mite: 93.9, 98.9, 98.7 and 98.1 % – 3, 7, 14 and 21 days after 1st treatment in 2006. Efficiency of Abamectin 18 g l⁻¹ (0.1 and 0.075 %) after 1st treatment against two-spotted spider mite was over 90 %.

There were found statistical differences of number of mines in leaf between all doses of Abamectin 1.8 g l⁻¹ and untreated plants 7, 9 and 10 days after treatment (Table 5). The number of mines in leaf was significant less in Abamectin 1.8 g l⁻¹ (0.12 and 0.1 %) treated plants compare with Azadirachtin A 50 g l⁻¹ and Spirodiclofen 240 g l⁻¹ treated plants 7, 9 days after treatment in 2005. The number of mines was significant less in Abamectin 0.12 % treated plants than Azadirachtin A and Spirodiclofen treated plants after 7 and 14 days after treatment in 2006. There were not found any statistical differences of number of mines in leaf between Abamectin all doses, except the highest and lowest doses after 9 days after treatment in 2005.

Table 4. Efficiency of insecticide Abamectin applied against two-spotted spider mite (*Tetranychus urticae*) after first application

4 lentelė. Insekticido abamektino efektyvumas nuo paprastųjų voratinklinių erkių (*Tetranychus urticae*) po pirmojo purškimo

Babtai, 2005–2006

Treatments Variantas	Biological efficiency Biologinis efektyvumas (%)		
	3 days after treatment praėjus 3 d. po purškimo	7 days after treatment praėjus 7 d. po purškimo	9 days after treatment praėjus 9 d. po purškimo
2005			
Untreated Nepurkšta	-	-	-
Abamectin 0.12 %	92.24	98.40	100
Abamectin 0.10 %	82.76	97.20	99.16
Abamectin 0.075 %	81.03	94.80	100
Abamectin 0.05 %	78.02	95.60	82.28
Azadirachtin 0.5 %	63.79	89.60	83.12
Spirodiclofen 0.05 %	59.48	90.80	84.39
2006			
Untreated Nepurkšta	-	-	-
Abamectin 0.12 %	93.91	98.93	98.71
Abamectin 0.10 %	90.12	96.73	87.40
Abamectin 0.075 %	77.97	95.28	81.45
Abamectin 0.05 %	72.36	93.98	72.40
Azadirachtin 0.5 %	57.90	82.88	61.49
Spirodiclofen 0.05 %	61.92	88.78	60.59

Table 5. Damaged leaves of miner fly larvae on cucumbers after the first application
5 lentelė. Minamusių lervų pažeisti lapai po pirmojo purškimo

Babtai, 2005–2006

Treatments Variantas	Number of mines in leaf Minų skaičius lape					
	2005			2006		
	before treatment prieš purškimą	7 days after treatment praėjus 7 d. po purškimo	9 days after treatment praėjus 9 d. po purškimo	before treatment prieš purškimą	7 days after treatment praėjus 7 d. po purškimo	14 days af- ter treatmen praėjus 14 d. po purškimo
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
Untreated Nepurkšta	0.50	0.42 d	0.45 f	0.35	0.27 d	0.30 d
Abamectin 0.12 %	0.55	0.12 a	0.12 a	0.32	0.05 a	0.10 a

Abamectin 0.10 %	0.42	0.12 a	0.15 ab	0.37	0.07 ab	0.12 ab
Abamectin 0.075 %	0.45	0.20 ab	0.22 abc	0.27	0.10 ab	0.15 abcd
Abamectin 0.05 %	0.52	0.22 ab	0.25 bcd	0.25	0.12 ab	0.15 abcd
Azadirachtin A 0.5 %	0.45	0.32 bcd	0.37 def	0.30	0.20 bcd	0.25 bcd
Spirodiclofen 0.05 %	0.45	0.30 bcd	0.35 cdef	0.32	0.20 bcd	0.22 abcd

Note: Means followed by the same letter are not different significantly ($P = 0.05$) according to Duncan's multiple range test

Pastaba: Reikšmės, pažymėtos tomis pačiomis raidėmis, pagal Dunkano kriterijų ($P = 0,05$) iš esmės nesiskiria.

Abamectin 18 g l⁻¹ 0.12 % effectively reduced the number of mines in leaves (Table 6). Efficiency of Abamectin 18 g l⁻¹ (0.1, 0.075 and 0.05 %) was lower. Efficiency of Azadirachtin A 50 g l⁻¹ and Spirodiclofen 240 g l⁻¹ was low. The lowest efficiency of almost all treated active ingredients was 14 days after treatment.

Table 6. Efficiency of insecticide Abamectin against miner flies after the first application

6 lentelė. Insekticido abamektino efektyvumas nuo minamusių po pirmojo purškimo

Babtai, 2005–2006

Treatments Variantai	Biological efficiency Biologinis efektyvumas (%)			
	2005		2006	
	7 days after treatment praėjus 7 dienoms po purškimo	9 days after treatment praėjus 9 dienoms po purškimo	7 days after treatment praėjus 7 dienoms po purškimo	14 days after treatment praėjus 14 dienų po purškimo
Untreated Nepurkšta	-	-	-	-
Abamectin 0.12 %	71.43	75.80	80.30	63.60
Abamectin 0.10 %	65.99	60.40	75.26	62.20
Abamectin 0.075 %	47.09	54.40	51.39	35.90
Abamectin 0.05 %	46.63	46.60	48.15	30.70
Azadirachtin 0.5 %	15.35	8.50	13.53	3.40
Spirodiclofen 240 SC 0.05 %	28.58	13.40	18.80	19.80

It was no observed negative direct effect on crop, beneficial fauna or pest resistance of insecticide Abamectin 18 g l⁻¹.

Discussion. The number of various acaricides and insecticides were tested against two-spotted spider mite, *Tetranychus urticae* Koch. in different countries (Herron and Rophail, 1998; Nauen et al., 2001; Castagnoli et al., 2005). Three active ingredients from different chemical classification were tested in this study. The higher rates of Abamectin 1.8 g l⁻¹ (0.12, 0.1, 0.075 %) effectively protected cucumbers against mites 14 days after treatment. Lowest rate (0.05 %) of Abamectin less affected mites, but statistically this effect differed only 9 days after first application in 2005. Only the highest rates of Abamectin (0.12, 0.1 %) efficiently reduced damage of miner fly

larvae. Azadirachtin A 10 g l⁻¹ and Spirodiclofen 240 g l⁻¹ were less effective against two-spotted spider mite and not enough effective against miner flies. Spirodiclofen 240 g l⁻¹ (0.5 l/ha) was less effective too, when in strawberry this insecticide (0.4 l/ha) was high efficient against two-spotted spider mite (Raudonis et al., 2005).

According to Ochoa and Carballo (1993) Abamectin applied at the commercially recommended dosage, showed a satisfactory level of control of the eggs and larvae of *Liriomyza huidobrensis*. Lower dosages were less effective, like in our study. Abamectin provides residual activity in the field because of its translaminar action and rapid penetration of leaf tissue (Dybas, 1989), maybe this proposition explain why this active ingredient is more effective against leaf miner flies than Azadirachtin and Spirodiclofen. One of the new methods according to Luksienė et al. (2005) results in exposition of insects to the bait, containing hematoporphyrin dimethyl ether and following irradiation with visible light resulted in total killing of *Liriomyza bryoniae* adults.

The ability of *T. urticae* to develop resistance to several acaricides has caused problems in many countries involved in agricultural production during the past 40 years (Herron, Rophail, 1993; Hinomoto, Takafuji, 1995; Stumpf, Nauen, 2001). Because of resistance problems it is more difficult to control leaf miner flies worldwide (Parrella et al., 1985). After 7–8 years of widespread commercial use of abamectin in pear orchards all *T. urticae* populations collected from pear showed low to moderate levels of resistance (Beers et al., 1998). The percentage of resistant mites to Abamectin decreased to levels equal or lower than 15 % in six months (Sato et al., 2005). Among *T. urticae* populations no resistance against abamectin was found in a population than had been subjected to fewer than 6 applications per year (Campos et al., 1995). In our experiment there was no observed negative direct effect on crop, beneficial fauna or pest resistance of insecticide Abamectin 18 g l⁻¹. Trumble and Morse (1993) reported that the best economic returns were generated by abamectin against *T. urticae* in combination with *Phytoseiulus persimilis*. This indicates that the chemical application of two-spotted spider mite can be successfully integrated with biological control. Abamectin is not only highly effective but it comes from biological source, which can be used in an environmentally friendly manner (have relatively low toxicity to many non-target arthropods) in integrated pest management programs (Dybas, 1989).

Conclusions. 1. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.12 % against two-spotted spider mite was 92.24–100 %, against leaf miner flies it was 63.6–80.3 %. Abamectin 18 g l⁻¹ 0.12 % was effective against two-spotted spider mite till 14 days, against leaf miner flies – 9 days.

2. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.1 % against two-spotted spider mite was 82.8–99.2 %, against leaf miner flies – 60.4–75.26 %. Abamectin 18 g l⁻¹ 0.10 % was effective against two-spotted spider mite till 14 days, against leaf miner flies – 7 days.

3. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.075 % against two-spotted spider mite was 81.0–100 %, against leaf miner flies – 35.9–54.4 %. Abamectin 18 g l⁻¹ 0.075 % was effective against two-spotted spider mite till 14 days, against leaf miner flies was not enough effective.

4. Efficiency of insecticide Abamectin 18 g l⁻¹ 0.05 % against two-spotted spider mite was 72.4–94.0 %, against leaf miner flies – 30.7–49.6 %. Abamectin 18 g l⁻¹ 0.05 % was effective against two-spotted spider mite till 14 days, against leaf miner flies was not enough effective.

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Abamektino poveikis paprastosioms voratinklinėms erkėms ir minamusėms šiltnamio agurkuose

L. Duchovskienė

Santrauka

2005–2006 m. tirtas abamektino 18 g l⁻¹ poveikis paprastosioms voratinklinėms erkėms (*Tetranychus urticae* Koch.) ir minamusėms (*Liriomyza strigata*, *Liriomyza bryoniae*) šiltnamio agurkuose. Abamektino 18 g l⁻¹ 0,12 % ir 0,1 % koncentracijų efektyvumas nuo paprastųjų voratinklinių erkių buvo atitinkamai 92,24–100 % ir 82,8–99,2 %. Abamektino 18 g l⁻¹ 0,075 % ir 0,05 % koncentracijų efektyvumas nuo paprastųjų voratinklinių erkių buvo atitinkamai 81,0–100 % ir 72,4–94,0 %. Abamektino 18 g l⁻¹ 0,12 % ir 0,1 % koncentracijų efektyvumas nuo minamusių buvo atitinkamai 63,6–80,3 % ir 60,4–75,26 %. Abamektino 18 g l⁻¹ 0,075 % ir 0,05 % koncentracijų efektyvumas nuo minamusių buvo atitinkamai 35,9–54,4 % ir 30,7–49,6 %. Azadirachtino A 10 g l⁻¹ 0,5 % koncentracijos ir spirodiklofeno 240 g l⁻¹ 0,05 % koncentracijos efektyvumas nuo paprastųjų voratinklinių erkių ir minamusių buvo mažesnis.

Reikšminiai žodžiai: abamektinas, agurkai, azadirachtinas A, *Liriomyza bryoniae*, *Liriomyza strigata*, spirodiklofenas, *Tetranychus urticae*.