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Application methods and dosages of thiamethoxam in thrips control on tomato plants

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ABSTRACT

Thrips is one of the most important vector species of the tomato spotted wilt tospovirus (TSWV) in Brazil. Two different pesticide application methods, drench x spray, using thiamethoxam were compared with commonly used insecticides for thrips control in tomato plants, Debora Plus. The experimental design consisted of a complete randomized block design with seven treatments and four replicates. Dosages of 150 and 200 g of a.i. per ha were used in just one drench application and 50 g of a.i. ha^{-1} sprayed, at weekly intervals, 48 days after sowing. The control efficacy of thiamethoxam was compared to diafenthiuron (400 g of a.i. ha^{-1}), profenofos + cypermethrin (320+32 g of a.i. ha^{-1}, respectively) and methamidophos (60 g of a.i. per hectolitre of water) in spray application. Cumulative number of plants with tospoviruses and the *F. schultzei* population from ten flowers per plot were registered. The mean cumulative number of plants with tospoviruses among treatments was not significantly different. No significant difference between thiamethoxam application methods and dosages on *F. schultzei* control, 24 days after application, were observed for thrips population. One drench application of higher dosages of thiamethoxam proved to be more environmentally advantageous than the pesticide applied at dosages of 50 g of a.i. ha^{-1} at weekly intervals. The vector control efficacy of thiamethoxam varied from 93 to 95%, independently of the application method and dosages. Diafenthiuron and profenofos + cypermethrin showed less efficacy (78 and 88%, respectively) but greater than those with methamidophos (71%). The products and dosages tested did not cause phytotoxicity in tomato leaves.

Keywords: *Lycopersicon esculentum*, *Frankliniella schultzei*, drench application, spraying, chemical control.

RESUMO

Métodos de aplicação e dosagem de thiamethoxam no controle de tripes em tomate

O tripes *Frankliniella schultzei* Trybom (Thysanoptera: Thripidae) é um dos mais importantes vetores de tomato spotted wilt tospovirus (TSWV) na cultura do tomate no Brasil. Dois métodos de aplicação do inseticida thiamethoxam foram comparados no controle de tripes em tomate. O experimento foi conduzido em delineamento de blocos ao acaso com sete tratamentos e quatro repetições. Utilizou-se um pulverizador costal manual com lança simples provida de ponta de pulverização com jato cônico vazio JD 14-2 ou modificada, com aplicador tipo esguicho, em substituição à ponta de pulverização. Dosagens de 150 e 200 g i.a. ha^{-1} foram usadas em única aplicação com esguicho e 50 g i.a. ha^{-1} em pulverizações semanais, iniciadas aos 48 dias após a semeadura. A eficiência do inseticida em teste foi comparada com diafenthiuron (400 g i.a. ha^{-1}), profenofos + cypermethrin (320+32 g i.a. ha^{-1}, respectivamente) e methamidophos (60 g i.a. 100 L^{-1} de água), aplicados em pulverização. Não houve diferença estatística entre os métodos de aplicação e doses com thiamethoxam no controle de *F. schultzei* aos 24 dias após a aplicação, sendo vantajosa a realização de uma única aplicação das maiores dosagens de thiamethoxam com esguicho em comparação às aplicações semanais da menor dosagem em pulverização. A eficiência de controle do tripes com o inseticida thiamethoxam variou de 93 a 95%, nos diferentes métodos e dosagens em teste. Diafenthiuron e profenofos + cypermethrin apresentaram eficiência menor (78 e 88%, respectivamente), porém foram superiores às obtidas com methamidophos (71%). Os produtos e doses utilizados não causaram fitotoxicidade às plantas de tomate.

Palavras-chave: *Lycopersicon esculentum*, *Frankliniella schultzei*, esguicho, pulverização, controle químico.

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In Brazil, the diseases caused by *Tospovirus* (type species: tomato spotted wilt virus, TSWV) result in large losses in several vegetable and floral crops (Nagata *et al.*, 1999). More than ten species of thrips are vectors of tospoviruses and five of them have been detected. Among thrips species, *Frankliniella schultzei* Trybom (Thysanoptera: Thripidae) was reported as the main species found in tomato crops in São Paulo State (Pavan *et al.*, 1993) and as an important specie vector of the TSWV (De Ávila *et al.*, 1998).

Nagata *et al.* (2000) studied the transmission specificity and efficiency of Brazilian tospoviruses occurring on tomatoes caused by four thrips species. The results indicated that *F. occidentalis* and *F. schultzei* are the major *Tospovirus* vectors on tomato. However, *Thrips tabaci* and *Thrips palmi* probably do not play an important role on *Tospovirus* distribution in tomato field.

Tospoviruses are transmitted by thrips in a persistent manner (Sakimura, 1962). The virus can be acquired only at the larval stages, and virus transmission is due, almost exclusively, to adult thrips. Larvae can not transmit the virus immediately after acquisition, but after a latent period of approximately 3 to 10 days (Wijkamp, 1995). The dark color form of *F. schultzei* is able to transmit a greater number of tospoviruses compared to the light color

form (Wijkamp *et al.*, 1995). Domiciano (1995) verified that the thrips species *F. schultzei*, *Tospovirus* vector, even at low population levels, caused significant reduction in tomato productivity. Insecticide treatments (weekly) in the first 40 days after transplant were essential to prevent plants being infected with the virus and causing significant yield reduction.

The effect of thiamethoxam in preventing transmission of Sardinian tomato yellow leaf curl virus (TYLCV) by *Bemisia tabaci* (Gennadius) was studied in experimental transmissions to tomato seedlings, cv. Marmande. Dosages of 50 ppm a.i. and 7 mg a.i. per plant were evaluated for the foliage and drench applications, respectively. Drench application provided a good level of protection from TYLCV infections in all tested conditions (from 1 to 22 days after treatment application); foliage application resulted in a prompt but short-lasting protection, less than 8 days (Mason *et al.*, 2000).

In São Paulo State, during the summer season, an increase reproduction rate of this insect occurs. The disease disseminates quickly, causing complete loss (Tokeshi & Carvalho, 1980).

Generally, chemical control of *F. schultzei* has been efficient with high-volume (hand knapsack sprayers) and systemic products, for example methamidophos (60 g of a.i. 100 L^{-1} of water). High frequency insecticide spraying using conventional methods, three times a week, increases the exposure of the applicators as well as the cost of crop production, and causes environmental hazards.

In Brazil, Bayer Crop Protection Division developed the drench application to control pests in tobacco crops. This application method using systemic products provides chemical protection to foliage as well as to the root system, reducing the frequency of application.

In the present experiment were two different pesticide application methods compared, drench and spray application, and the efficiency of thiamethoxam against diafenthiuron, profenofos + cypermethrin and methamidophos insecticide spraying for thrips control in tomato crops.

MATERIAL AND METHODS

The experiment was carried out at an experimental farm located in São Manoel, São Paulo State, Brazil. Debora Plus tomato hybrid, trained vertically and spaced 1.50 x 0.40 m was cultivated in field conditions. The experimental design was of complete randomized blocks with seven treatments and four replicates. Each experimental plot was composed of two ten-meter lines with 25 plants, with a total of 50 plants. Of these plants, just 40 were analyzed as ten were on borders and could be affected by another treatment.

One knapsack sprayer was used in pesticide applications consisting of a simple lance with one JD 14-2 hollow cone type nozzle or modified lance at the end for spray or drench application, respectively. The treatments were thiamethoxam in one drench application at dosages of 150 and 200 g of a.i. ha^{-1}, 48 days from sowing (February 28th, 1999); thiamethoxam in six spray applications at dosages of 50 g of a.i. ha^{-1} at weekly intervals; diafenthiuron (400 g of a.i. ha^{-1}), profenofos + cypermethrin (320+32 g of a.i. ha^{-1}, respectively); methamidophos (60 g of a.i. 100 L^{-1} of water) applied as the last method of application, plus the control (no insecticide application).

During the period of the experiment two preventive fungicide applications were carried out on March 15th and 24th 1999 with chlorothalonil at a dosage of 100 g of a.i. 100 L^{-1} of water and tebuconazole + mancozeb at a dosage of 25+480 g of a.i. 100 L^{-1} of water.

The thrips population was evaluated before (on February 24th, 1999) and after the initial insecticide applications on March 03rd, 10th, 18th, 24th, 31st and on April 6th, 1999. For the evaluation ten flowers per plot were collected and stored in plastic bags with 70% alcohol. Insect counting was carried out in laboratory conditions, using a stereoscopic microscope.

Cumulative number of plants with tospoviruses was registered. *F. schultzei* numbers from ten flowers per plot plus cumulative data were submitted to variance analysis and means compared by Tukey test at 5% probability. Data were transformed to $(x + 0.5)^{1/2}$ for analysis.

The control efficiency of thrips was determinate by Abbott formula (Nakano *et al.*, 1981) through the cumulative number of plants with tospoviruses symptoms.

RESULTS AND DISCUSSION

The average application volume using knapsack sprayer varied from 1067 to 1554 L ha^{-1} and in drench application was 350 L ha^{-1}.

Little difference in the number of thrips was registered when comparing the plots of tomatoes exposed to the various treatments after 3, 10 and 18 days. However, at 24 days only thiamethoxam (150 g of a.i. ha^{-1}) applied in drench and profenofos + cypermethrin (320+32 g of a.i. ha^{-1}, respectively) in weekly spraying showed significantly lower numbers of *F. schultzei* compared to those obtained with diafenthiuron (400 g of a.i. ha^{-1}) on tomato plants. No difference was observed among the other treatments (Table 1).

After applications, the insecticide thiamethoxam at dosages of 150 and 200 g of a.i. ha^{-1} (drench application) and at a dosage of 50 g of a.i. ha^{-1} (weekly spraying application), as well as, profenofos + cypermethrin (320+32 g of a.i. ha^{-1}, respectively) showed the best results with lowest cumulative number of plants with tospoviruses and the greatest efficiency of thrips control (Tables 2 and 3). Thrips control for these insecticides were of 93; 93; 95 and 88%, respectively, 24 days after the initial application.

Intermediate efficiency of *F. schultzei* control was obtained with diafenthiuron (400 g of a.i. ha^{-1}) and methamidophos (60 g of a.i. 100 L^{-1} of water) insecticides (Table 3). The values were 78 and 71%, respectively.

The number of thrips in tomato flowers is not a good parameter to evaluate the efficiency of thrips control. Frequently, tomato plants can be infected but the vector species is not

Table 1. Mean number of *Frankliniella schultzei* in tomato flowers after insecticide treatments applications with conventional spraying (knapsack sprayer) and drench application on tomato crops. São Manoel, UNESP, 1999.

Treatments	Application method	Days after application			
		3	10	18	24
Thiamethoxam (50 g a. i. ha-^{1})	Spraying	0.01 ± 0.0a²	0.0 ± 0.0a	0.7 ± 0.5a	1.0 ± 0.4ab
Thiamethoxam (150 g a. i. ha^{-1})	Drench	0.0 ± 0.0a	0.5 ± 0.3a	0.7 ± 0.7a	0.2 ± 0.2 b
Thiamethoxam (200 g a. i. ha^{-1})	Drench	0.7 ± 0.5a	0.5 ± 0.3 a	0.5± 0.5a	0.7 ± 0.5ab
Diafenthiuron (400 g a. i. ha^{-1})	Spraying	0.0 ± 0.0a	0.5 ± 0.5a	3.5 ± 2.5a	2.7 ± 0.2a
Profenofos + cypermethrin (320+32 g a.i. ha^{-1})	Spraying	0.0 ± 0.0a	0.0 ± 0.0a	0.7 ± 0.7a	0.5 ± 0.3 b
Methamidophos (60 g a. i.100L^{-1})	Spraying	0.2 ± 0.2a	0.0 ± 0.0a	1.5 ± 0.9a	1.0 ± 0.4ab
Control	-	0.7 ± 0.5a	0.7 ± 0.5a	2.5 ± 1.3a	1.2 ± 0.5ab
CV(%)	-	30.12	32.58	57.70	28.33

Original data transformed to $(x + 0.5)^{1/2}$ for analysis.
[1] Samples = 10. ² Numbers in columns followed by the same letter are not significantly different at the 5% level with Tukey test.

Table 2. Mean cumulative number of tomato plants with tospoviruses after insecticide applications with conventional spraying and drench application on tomato crops. São Manoel, UNESP, 1999.

Treatments	Application method	Days after application			
		3	10	18	24
Thiamethoxam (50 g a. i. ha^{-1})	Spraying	0.21 ± 0.2a²	0.2 ± 0.2 b	0.5 ± 0.3 c	0.7 ± 0.5 c
Thiamethoxam (150 g a. i. ha^{-1})	Drench	0.2 ± 0.2a	0.5 ± 0.3 b	0.5 ± 0.3 c	0.7 ± 0.2 c
Thiamethoxam (200 g a. i. ha^{-1})	Drench	0.5 ± 0.3a	0.7 ± 0.2 b	0.7 ± 0.2 c	0.7 ± 0.2 c
Diafenthiuron (400 g a. i. ha^{-1})	Spraying	1.2 ± 0.2a	1.7 ± 0.5ab	1.7 ± 0.5 bc	2.2 ± 0.2 bc
Profenofos + cypermethrin (320+ 32 g a.i. ha^{-1})	Spraying	0.5 ± 0.5a	0.7 ± 0.5 b	1.0 ± 0.4 bc	1.2 ± 0.2 bc
Methamidophos (60 g a. i.100L^{-1})	Spraying	1.5 ± 0.5a	3.0 ± 0.4a	3.0 ± 0.4 b	3.0 ± 0.4 b
Control	-	1.5 ± 0.3a	2.0 ± 0.7ab	7.2 ± 1.1a	10.2 ± 1.5a
CV(%)	-	26.57	25.64	21.14	18.46

Original data transformed to $(x + 0.5)^{1/2}$ for analysis.
[1] Samples = 40. ² Numbers in columns followed by the same letter are not significantly different at the 5% level with Tukey test.

Table 3. Percentage of *Frankliniella schultzei* control after insecticide applications with conventional spraying and drench application on tomato crop. São Manoel, UNESP, 1999[1].

Treatment	Application method	Days after application			
		3	10	18	24
Thiamethoxam (50 g a.i. ha-1)	Spraying	83%	88%	93%	95%
Thiamethoxam (150 g a.i. ha-1)	Drench	83%	75%	93%	93%
Thiamethoxam (200 g a.i. ha-1)	Drench	67%	63%	90%	93%
Diafenthiuron (400 g a.i. ha-1)	Spraying	17%	13%	76%	78%
Profenofos + cypermethrin (320+32 g a.i. ha-1)	Spraying	67%	63%	86%	88%
Methamidophos (60 g a.i. 100L-1)	Spraying	0%	50%	59%	71%
Control	-	-	-	-	-

[1] Efficiency (%) determinate by Abbott formula.

always present. In thrips populations many of the insects are not viruliferous. Moreover, there is evidence that an increase in virus incidence can be a result from pesticide application, presumably because viruliferous thrips are dispersed during spraying and the disease transmitted before the insect is affected (Allen *et al.*, 1993).

Counting only the infected tomato plants in the evaluation, is not enough. The tomato plants infected by TSWV show tospoviruses symptoms only 12 to 15 days after the virus transmission. This occurrence can underrate or overrate the counting of tomato plants with symptoms of tospoviruses. The cumulative number of plants with symptoms in different degrees of severity is a more appropriate parameter for the efficiency evaluation.

Thiamethoxam insecticide in all dosages and different application methods provided a high control level of *F. schultzei* in tomato crops. Similar results were obtained by profenofos + cypermethrin on thrips, despite the mixture of two products with contact action. Higher dosages of thiamethoxam using drench application were advantageous in comparison to lower dosages (weekly spraying application) because of reduction in the frequency of applications.

None of the insecticides used in the tests, at any dosage, caused phytotoxicity in tomato crops.

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