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Spirotetramat (Movento®): new systemic insecticide for control of green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphidae) on peach

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Abstract

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The green peach aphid (*Myzus persicae*) is one of the most common and most harmful species of aphids on the peach in the world. It is a serious problem for many industrial and vegetable crops and vector of various economically important viruses on them. The control of this species of aphids is extremely difficult due to the specific life cycle, the high reproductive potential, the wide range of hosts, the ability to spread rapidly and the development of resistance to different groups of insecticides. A series of field experiments was carried out in the spring of 2016/2017 to improve the control of this species of aphids. The purpose of these experiments was to evaluate and compare the efficacy of spirotetramat (Movento®) used to control *M. persicae* with that of neonicotinoids imidacloprid or thiamethoxam when applied alone after flowering. The results show that spirotetramat demonstrates excellent efficacy and very good persistance, allowing effective control of *M. persicae* populations for more than a month. Movento®, applied once after flowering, provides excellent and reliable control of *M. persicae* populations, significantly superior to that of neonicotinoids imidacloprid and thiamethoxam in terms of efficacy and persistence.

Spirotetramat can be considered as a reliable means of controlling *M. persicae* and a possible alternative to neonicotinoid insecticides to reduce the risk of mass multiplication and resistance occurrence. The best time for its application is after flowering before or in the presence of first visible colonies of *M. persicae* on the peach shoots.

Keywords: peach; green peach aphid; spirotetramat; imidacloprid; thiametoxam; efficacy
Abbreviations: GPA – green peach aphid

Introduction

Green peach aphid (GPA), *Myzus persicae* (Sulzer) is one of the most widespread species of aphids in the world. It is a typical polyphage that attacks more than 500 plant species from at least 40 different botanical families (Grigorov, 1980; Blackman & Eastop, 2000). GPA is a migratory species. In Bulgaria it is a key pest for peaches, while for other species of the genus Prunus it is not so harmful. In our country it is a binomial holocyclic species, with the main host peach and other species of the genus Prunus, and secondary hosts – a large number of herbaceous species (tomatoes, cucumbers, pepper, potatoes, tobacco, cotton, sugar beet and others). GPA sucks juice causing damage to plants and generates abundant "honey dew", but its damage as a vector of some economically important viruses on spring and summer hosts is significantly greater (Kennedy, 1962; Capote et al., 2006).

In Bulgaria *M. persicae* overwinters as eggs on host trees, especially peach near the buds. Eggs hatch well before leaf bud burst; nymphs attack blossoms then growing shoots and leaves. GPA infestations on blossoms and new shoots cause flowers and leaves to curl tightly and shoot to stop growing. Fruitlets may not develop or may drop; young peaches may be deformed and nectarines may be

deformed and streaked with russet. After 2-3 generations of peach, winged forms emigrated in June to produce several generations (16-20) on summer hosts. In the fall, winged forms return to the spring hosts to lay overwintering eggs.

In the industrial peach gardens, the control of *M. persicae* is most commonly carried out through the application of systemic aphicides in the early-spring period. The control is either before or after flowering, depending on the density of the aphids and the level of damage (2% attacked flower buds from „bud burst" to „pink button" before flowering and 5% attacked shoots in fruit formation – after flowering). Pre-flowering treatment is directed against the fundatrix before they have formed multiple colonies, and is carried out with flonicamide, pyrimicarb, or tau-fluvalinone-based admixtures, and post-flowering treatment is intended to effect complete control of the pest population and is carried out with insecticides based on neonicotinoids (acetamiprid, imidacloprid, thiomethoxam and clothianidin).

The withdrawal from the market of certain substances such as Pirimor WG, the problem of the emergence of resistance in *M. persicae* populations, the restrictions imposed in relation to the use of neonicotinoids in the pre-flowering period and the emergence of new active substances capable of controlling on aphids populations, provoked this study, aimed at updating the control strategy of GPA in industrial peach gardens.

Movento® (spirotetramat) is a representative of a new class of products – ketoenols derived from spirocyclic tetronic acid produced by Bayer Crop Science. It is the first active substance that has a two-way action, acropetal and basipetal, which has the ability to move both the xylem and the phloem after foliar treatment. It acts as an inhibitor of lipid biosynthesis in the insect body after ingestion (Nauen et al., 2008; Brück et al., 2009; Cantoni et al., 2008; Roffeni et al., 2010). For this reason, it is extremely active against juvenile stages of insects with piercing-sucking mouthparts. (De Maeyer et al., 2002).

The purpose of this study is to evaluate the efficacy of spirotetramat (Movento®) used to control *Myzus persicae* in order to improve the system of controlling aphids in peach gardens.

Material and Methods

Field experiments to evaluate the efficacy of spirotetramat (Monvento®) against *Myzus persicae* Sulz. were conducted in industrial peach gardens located near Plovdiv in 2016 and 2017. The surveys were conducted in two peach gardens on 11-year-old peach trees, Red Haven cultivar, grown as a vase on GF 377, at a planting pattern of 5 x 3 m. Activity of spirotetramat applied for post-flowering control of *M. persicae*, was compared with that of neonicotinoids (imidacloprid and thiamethoxam). The products used in the tests and their main characteristics are presented in Table 1.

Spirotetramat (Movento 100 SC – spirotetramat 100 g/L) was applied at two different moments from the population development of *M. persicae*: in 2016 – „preventive" (23.04), in the „petal fall" phase (before the presence of *M. persicae* columns), and in 2017 – „therapeutically" after flowering in the presence of first colonies of *M. persicae* (20.04) (Table 1).

All experiments were set in a randomized block pattern of four replicates (five trees per replicate) for each treatment. Insecticidal treatments (1 per variant) were made using an aerosol sprayer simulating a working solution flow in rate of 15 hl/ha. The evaluation was performed visually on 25 shoots per replicate, each of which was assigned to an appropriate class of infection depending on the number of aphids available: Class 0 = 0 aphids; Class 1 = 1-5 aphids/3; Class 2 = 6-20 aphids/2; Class 3 = 21-80 aphids/1. The result gives an infestation value that expresses the number of normal colonies/100 shoots (Baggiolini, 1965). The data for normal colonies for variants were subjected to a variance analysis (ANOVA) and a difference between the mean values compared to the Tukey ($p < 0.05$) и Duncan.

Results and Discussion

Test 2016. The results of this test are presented in Table 2. The observations carried out at the end of flowering (23.04) did not indicate the presence of *M. persicae* colonies on the peach tree shoots, but preventive treatment with the relevant products in all pesticide variants has been done with a view to limiting the population of nonwinged (apterous) female (foundatrix) that is viviparous. First visible infesta-

Table 1. Characteristics of tested insecticides to control *M. persicae*

Test variants	Commercial formulation	Active substance	Active substance (%)	Formulation	Dose g ml/hl	Time of application	Date of treatment	
							2016	2017
1	Movento	Spirotetramat	100	SC	100	(BBCH 69)	23.04	20.04
2	Confidor	Imidacloprid	20	SL	50	(BBCH 69)	23.04	20.04
3	Actara	Thiametoxam	25	WG	25	(BBCH 69)	23.04	20.04

Table 2. Mean values of *M. persicae* expressed as number of normal colonies/100 shoots (2016)

Test variants / products	Dates of sampling					
	23 April	30 April	7 May	10 May	17 May	23 May
	T-0	T+7	T+14	T+21	T+28	T+34
Untreated plot	0	2.9 a*	13.7 b	23.7 b	30.2 b	22.1 b
Spirotetramat	0	0 a	0 a	0.3 a	1.0 a	1.1 a
Imidacloprid	0	0 a	1.1 a	3.1 ab	4.2 ab	5.9 ab
Thiametoxam	0	0.03 a	2.5 a	4.0 ab	5.2 ab	9.1 ab

*Values in the same column marked with different letters differ significantly from each other for $p \leq 0.05$ (Tukey's test HDS)
T – days after treatment

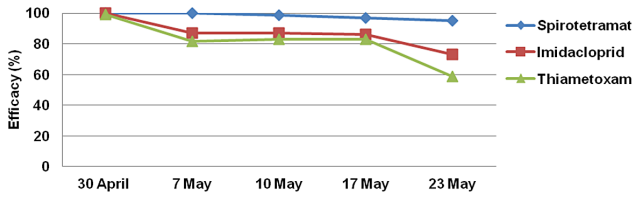

Fig. 1. Efficacy of the tested products in 2016

tions of the shoots were recorded a week later in all experimental variants, except that with spirotetramat. Significant variations in colonies of *M. persicae* were observed between control and test variants, which are indicative of high initial activity of all tested products. In this test, spirotetramat demonstrated a high and prolonged activity to *M. persicae* populations, which in terms of efficacy and persistence, outweighed that of neonicotinoids (imidacloprid and thiamethoxam) (up to 96.7% efficacy at day 28 after treatment with spirotetramat versus 86.1% and 82.8% efficacy, for imidacloprid and thiamethoxam, respectively (Fig. 1).

Test 2017. The results of this test are presented in Table 3. In 2017 the first visible infestations on shoots were observed at the end of flowering. The treatments in the pesticide plots were done on 20.04 at low numbers of *M. persicae* in the colonies. Post-treatment observations showed a slight increase in the numbers of *M. persicae* in the pesticide treated plots, unlike in the untreated plot. These differences have become increasingly distinct and significant with each subsequent observation, which is evidence of the high efficacy of all tested products. In this test, spirotetramat again showed high and prolonged activity against *M. persicae* populations, which is significantly better than those of the reference insecticides imidacloprid and thiamethoxam (up to 95% efficacy at 28 days post treatment for spirotetramat versus 75.6 and 69.8% efficacy, respectively for imidacloprid and thiamethoxam (Fig. 2).

The results of the two-year tests related to establishing the efficacy of spirotetramat against the *M. persicae* populations are similar. They very well illustrate the high activity and prolonged persistence of spirotetramat as already observed by other authors at other times and under other conditions (Pasqualini et al., 2014), as well as other phytophagous species (Pasqualini and Civolani, 2010; Pasqualini et al., 2012; Arnaudov, 2018).

It should be noted that the efficacy values of spirotetramat calculated on the Abbott formula and expressed as % of the control are not only high enough but also consistent and maintained at a high level in time, allowing it to maintain the *M. persicae* at an economically harmless level for more than

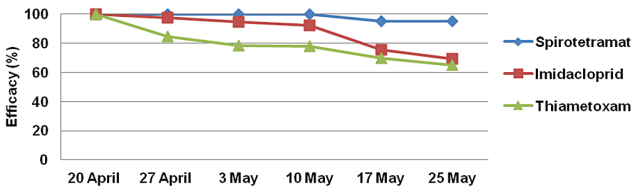

Fig. 2. Efficacy of the tested products in 2017

Table 3. Mean values of *M. persicae* expressed as number of normal colonies/100 shoots (2017)

Test variants / products	Dates of sampling					
	20 April	27 April	3 May	10 May	17 May	25 May
	T-0	T+7	T+14	T+21	T+28	T+35
Untreated plot	3.4 b*	12.1 b	22.1 c	32.7 c	36.1 b	31.7 b
Spirotetramat	0 a	0 a	0 a	0 a	1.8 a	1.6 a
Imidacloprid	0.02 a	0.3 a	1.2 b	2.6 b	8.8 ab	9.7 ab
Thiametoxam	0.04 a	1.9 a	4.3 b	7.3 b	10.9 ab	11.2 ab

*Values in the same column marked with different letters differ significantly from each other for $p \leq 0.05$ (Tukey's test HDS)
T – days after treatment

a month. This leads to the conclusion that single treatment with spirotetramat is fully sufficient to control the pest population and limit its harmful potential throughout the period of presence of *M. persicae* on the peach as a host.

Conclusion

Spirotetramat demonstrates excellent efficacy against *M. persicae* populations. In all tests, this product showed a very high and prolonged activity on the peach aphid populations that allowed it to effectively control this pest over a period of more than one month and in practice to provide protection for the peach for the entire period of its presence on that host. The spirotetramat (Movento®), applied once after flowering, ensures excellent and reliable control of the *M. persicae* populations, significantly superior in efficacy and persistence than that of the reference neonicotinoids imidacloprid and thiamethoxam. Its effect is significantly higher when applied „preventively", immediately after flowering, before the appearance of the first visible colonies, than „therapeutically", in the presence of existing colonies of *M. persicae*. Imidacloprid shows a slightly lower efficacy of spirotetramat and insignificantly better than this thiamethoxam, but still satisfactory to control *M. persicae* populations for more than 3-4 weeks.

All three insecticides may only be used for post-floral control of *M. persicae* populations after the prohibition (from 2014) of the use of neonicotinoid insecticides for pre-floral treatments in peach and restrictions on the time of application of spirotetramat (only after flowering fruit crops).

Spirotetramat can be considered as a reliable means of controlling *M. persicae* and a possible alternative to neonicotinoid insecticides to reduce the risk of mass multiplication and resistance occurrence. The best time for its application is after flowering before or in the presence of first visible colonies of *M. persicae* on the peach shoots.

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