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EFFICACY OF RECENT CHEMICAL INSECTICIDES AGAINST MEALY PLUM APHID *HYALOPTERUS PRUNI* ON PLUM AND SPIREA APHID *APHIS SPIRAECOLA* ON APPLE IN BULGARIA

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Abstract

The aim of this study was to establish the efficacy of new and little-known chemical insecticides, from different chemical classes, which are offered for control of Mealy plum aphid *Hyalopterus pruni* on plum and Spirea aphid *Aphis spiraecola* on apple in Bulgaria. Four products were tested - flupyradifurone (Sivanto prime), sulfoxaflor (Closer 120 SC), flonikamid (Teppeki 50WG) and acetamiprid (Mospilan 20SG). The tested concentrations of the chemical insecticides were applied according to their registrations for these and other pests. The experiments were carried out under field conditions. The results show that all the tested chemical insecticides are suitable for efficient control of both aphids, even at their lowest permitted concentration.

Keywords: insecticides, aphids, Sivanto Prime, Closer, Teppeki, Mospilan, *Hyalopterus pruni*, *Aphis spiraecola*

INTRODUCTION

More than 120 species of aphids (Hemiptera: Aphididae) on agricultural cops are described in Bulgaria (Grigorov et al, 2004). They can cause deformations and stunting of the shoots, exhaustion of plants and a significant reduction in yields even with large fruit trees in years with high population density. Their harmful activity is intensified by the transmission of viral diseases (Grigorov, 1980). Two of the most economically important species in fruit crops are Mealy plum aphid *Hyalopterus pruni* Geoffroy and Spirea aphid / Green citrus aphid *Aphis spiraecola* Patch. / *Aphis citricola* Van der Goot (Andreev et al, 2009; Vasilev and Andreev, 2013).

Mealy plum aphid is the most widespread species from this group of pests on plums and other stone fruits in Bulgaria (Vasilev and Andreev, 2013). It is a holocyclic facultative-migratory species. The winter hosts are *Prunus domestica*, *P. institita*, *P. cerasifera*, *P. spinosa*, and sometimes *P. persica*, *P. armeniaca* and *P. amigdalus*. Secondary (summer) hosts are: *Phragmites communis*, *Calamagrostis*, *Elymus* and *Arundo donax* (Nevskii, 1929; Bodenheimer and Swirski, 1957; Grigorov, 1980; Grigorov et al, 2004; Blackman and Eastop, 2004; CABI, 2022). Aphids suck sap during almost the entire growing season, excrete abundant "honey dew", significantly delay the growth and development of the attacked shoots, which later become smeary, distorted and their tips dry out. The density of the species is highest in June and July, but under suitable conditions large colonies can be seen as early as May (Vasilev and Andreev, 2013; Vasilev, 2016).

Spirea aphid is now distributed throughout the temperate and tropical regions worldwide (CABI, 2022). In Bulgaria, the species was found for the first time on apple in 2006 in the region of Plovdiv (Andreev et al, 2007). Its winter hosts are: *Spiraea spp.*, *Citrus spp.*, *Malus spp.* and *Carica papaya*. It has a

large number of secondary hosts from over 20 botanical families, mostly from: *Caprifoliaceae, Compositae, Rosaceae, Rubiaceae* and *Rutaceae* (Blackman and Eastop, 2004; CABI, 2022). Aphids suck sap, preferring to feed on juicy young tissue, which they find on the tops of shoots. They do not cause severe deformations, but significantly slow down growth (Andreev et al, 2009).

Different types of chemical insecticides are mainly used to control aphids in Bulgaria (BFSA, 2022).

In recent years, plant protection in Bulgaria has been subjected to significant changes. There is a process of replacement of all pesticides that do not meet the requirements of modern plant protection - highly toxic for bees, beneficial arthropods and vertebrates; having a high persistence; leading to serious violations in the stability of agrocenoses. These changes are related both to the general policy and some directives (regulations) of the EU, as well as to the Law on Plant Protection adopted in 2014 in our country. This meant that a number of widely used pesticides would be banned and farmers had to look for new products to replace those that are out of use and at the same time meet modern requirements, which could not be done without some upheaval. In terms of pest control, the almost complete ban on organophosphorus insecticides and neonicotinoids, that farmers were used to apply, has caused the greatest upheaval. On the other hand, pesticide-producing companies launched new products on the market, but they are little known for now, and the farmers meet them with a certain mistrust.

The aim of this study was to establish the efficacy of new and little-known chemical insecticides from different groups, which are recommended for control of Mealy plum aphid *Hyalopterus pruni* on plum and Spirea aphid *Aphis spiraecola* on apple in Bulgaria.

a

b

Fig. 1. Colonies of *Hyalopterus pruni* (a) and *Aphis spiraecola* (b)

MATERIALS AND METHODS

The experiments were carried out under field conditions, in the orchards of the experimental field of the Department of Entomology, at the Agricultural University - Plovdiv. The efficacy of four products from different chemical classes was tested against Mealy plum aphid on plum and Spirea aphid on apple: flupyradifurone (Sivanto prime), sulfoxaflor (Closer 120 SC), flonikamid (Teppeki 50WG) and acetamiprid (Mospilan 20SG) (tab. 1).

The two aphid species were identified on wingless adults. Microscopic slides were prepared using the modified Martin's method (1983). The modification consists in the use of heated lactic acid to enlighten the individuals (removal of soft tissue), instead of KOH. Identification was made using the Blackman and Eastop (2004) identification keys.

Table 1. List of the tested PPPs for control of *H. pruni* and *A. spiraecola*

Active ingredient	**Chemical class**	**Trade name**	**Concentration**
FLUPYRADIFURONE	butenolide	Sivanto prime i.a 200 g/L	0.05% and 0.09%
SULFOXAFLOR	sulfoximine	Closer 120SC i.a. 120 g/L	0.02% and 0.04%
FLONICAMID	pyridinecarboxamide	Teppeki 50WG i.a. 500 g/kg	0.01% and 0.015%
ACETAMIPRID (etalon)	neonicotinoid	Mospilan 20SG i.a. 200 g/kg	0.025%

Flupyradifurone (Sivanto prime) is a systemic insecticide with contact and stomach action for vegetative application, but it is also well absorbed by the roots. It penetrates translaminarly into plant tissues through the leaves while simultaneously moving systemically (acropetal) along the xylem. It belongs to a new chemical class - butenolides. Its action is similar to that of the neonicotinoids: activates the nicotinic acetylcholine receptors in the synapses. It causes tremors, paralysis, and death within 1 to 4 hours. It is effective against insects with piercing-sucking mouthparts. It is registered for the control of Spirea aphid at a dose of 900 ml/ha (0,09%). The standard and a reduced dose were tested.

Sulfoxaflor (Closer 120 SC) is a new class insecticide (sulfoximine) with contact and stomach action. In plants, it moves translaminarly and systemically along the xylem to the tips (acropetal). Its action on insects is similar to that of the neonicotinoids and can be their substitute – agonist (activator) of acetylcholine receptors (nAChRs) in synapses, but it exhibits structural activity, i.e. functions in a manner different from other insecticides acting on nAChRs. The insecticide effectively controls insects with piercing-sucking mouthparts, including those with resistance to systemic insecticides of other chemical classes. In Bulgaria, it is registered for the control of both species of aphids, but with two different doses/concentrations: until flowering the concentration is 200 ml/ha (0,02%); after the flowering of the fruit trees, it is doubled - 400 ml/ha (0,04%). The experiments were carried out after the flowering of both fruit species. Both registered doses were tested.

Flonikamid (Teppeki 50WG) is a systemic pyridine insecticide with contact and stomach action, which also penetrates in the treated plants by having a translaminar and acropetal movement in the plant. The product is an antifeedant - a neuroinhibitor of feeding activity. It causes spontaneous peristalsis of the digestive tract and makes feeding impossible. It is suitable for insects with piercing-sucking mouthparts. In Bulgaria, it has been known for a long time, but it is not registered for the control of aphids on fruit crops.

Acetamiprid (Mospilan 20SG) is a neonicotinic (chlornicotinyl) insecticide from the group of nitromethylenes. It has translaminar and systemic (mostly acropetal) movement in plants. It penetrates into the body of insects by contact and ingestion. Acetamiprid is a nicotinic agonist that reacts with nicotinic acetylcholine receptors (nACh-R). The activation of the nACh-R receptors causes hyperactivity and muscle spasms, and death. Acetamiprid is highly toxic to insects, but less to mammals. This is the last

insecticide from the group of neonicotinoids, authorized for use in Bulgaria. It is widely used to control insects with piercing-sucking mouthparts in a wide range of agricultural crops, including both test aphid species at a dose 250 g/ha (0,025%), therefore it was chosen as a standard.

The tested concentrations of the chemical insecticides were applied according to their registrations for these and other pests. The treatment was carried out with a hand sprayer on selected, medium-size colonies of both species of aphids, in which the individuals were previously counted. The control variant was treated with water. The live individuals were counted on the 1st, 3rd, 5th and 7th day after the treatment. All variants were set in 5 replicates, including the control. The results were processed using the Henderson & Tilton (1955) formula.

RESULTS AND DISCUSSION

The best action against *Hyalopterus pruni* of the tested chemical insecticides was shown by the products with active substances flupyradifuron (Sivanto Prime) and sulfoxachlor (Closer). At the higher applied concentrations (0,1% and 0,04%) the efficacy of both products reached 100% on the 5th day, and in the lower concentration - on the 7th day (Fig. 2). The product with the active ingredient flonikamid (Teppeki) also showed a very good effect, although its action was a bit slower. At the higher concentration (0.015%), the efficacy on the 1st day was over 90% and reached 100% on the 7th day. At the lower concentration (0.1%), the efficacy was lower. The product with active ingredient acetamiprid (Mospilan), which was used as a standard, also showed a very good effect against *H. pruni*, and on the 7th day after the treatment the efficacy reached 98.8%.

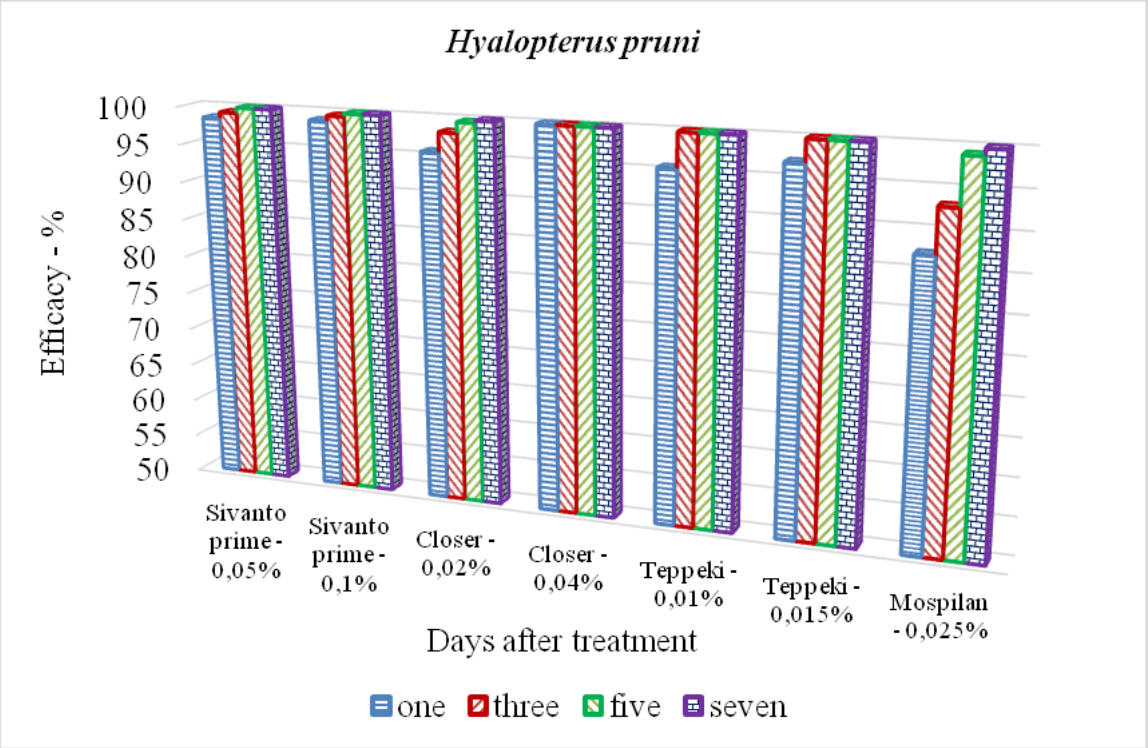

Fig. 2. Efficacy of chemical insecticides against Mealy plum aphid *Hyalopterus pruni* on plum under field conditions.

Of the tested chemical insecticides against *Aphis spiraecola*, the product with the active ingredient sulfoxachlor (Closer) was with the best and fastest acting. At the higher applied concentration (0.04%) the efficacy reached 100% on the 1st day after the treatment (Fig. 3). The product with the active ingredient flonicamid (Teppeki) also showed an excellent effect - the efficacy was 100% as early as the 3rd day after the treatment in both tested concentrations (0.01% and 0.015%). The action of flupyradifuron (Sivanto Prime) was also very good, which also reached 100% efficacy 5 days after the treatment at both applied concentrations (0.05% and 0.1%).

Studies on *A. spiraecola* during the period 2005-2008 showed that the species had a high degree of resistance to the insecticides used to control aphids - organophosphorus, carbamates, pyrethroids. The species could only be controlled with neonicotinoids (Rasheva, 2009). After the ban of most products from this group farmers faced difficulties in controlling this pest. The introduction of new effective insecticides can solve the problem and this was proved by the experiments carried out, as all three chemical insecticides that were tested reached 100% efficacy by the 7th day after the treatment.

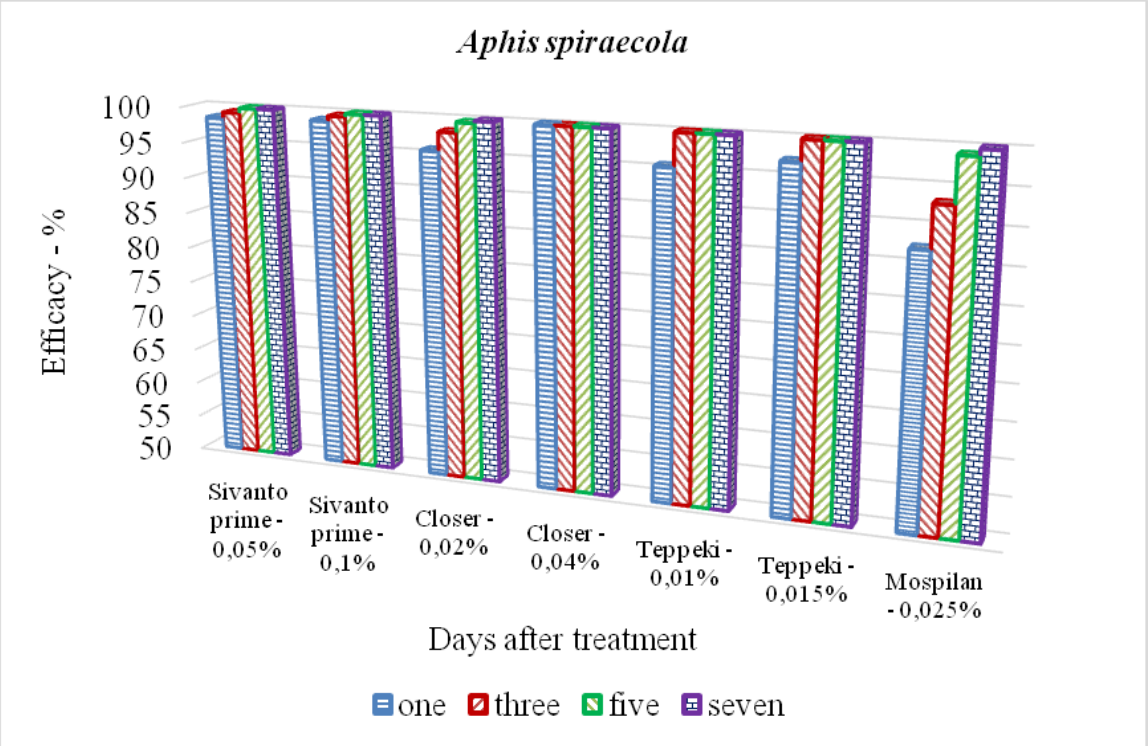

Fig. 3. Efficacy of chemical insecticides against Spirea aphid *Aphis spiraecola* on apple under field conditions.

CONCLUSION

1. The tested chemical insecticides showed excellent action against *Hyalopterus pruni*. Only Teppeki (flonicamid) in the lower concentration (0,01%) and the widely used Mospilan 20 SG (acetamiprid) did not reach 100% efficacy on the seventh day after the treatment, but they also came close to that result.

2. The tested insecticides showed even better action against *Aphis spiraecola*. Clouser (sulfoxachlor), in a concentration of 0.04%, showed the fastest effect and reached 100% efficacy on the 1st day after the treatment.

3. All tested chemical insecticides are suitable for efficient control of Mealy plum aphid *Hyalopterus pruni* on plum and Spirea aphid *Aphis spiraecola* on apple, even at their lowest recommended concentration.

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