In vivo insecticidal activity of cyclopentanespiro-5-hydantoin and its two derivatives towards Mealy plum aphid (*Hyalopterus pruni*) and their effect on *Prunus cerasifera*

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In vivo insecticidal activity of cyclopentanespiro-5-hydantoin and its two derivatives towards Mealy plum aphid (Hyalopterus pruni) and effect on Prunus cerasifera: The paper presents in vivo insecticidal activity of cyclopentanespiro-5-hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin) and 1aminocyclopentanecarboxylic acid towards Mealy plum aphid (Hyalopterus pruni) and their effect on Prunus cerasifera. It was found out that all the compounds exhibit excellent insecticidal action against the aphid. The tested compounds do not manifest any deleterious effects towards plant Prunus cerasifera.

Key words: Cyclopentanespiro-5-hydantoin, Cyclopentanespiro-5-(2,4-dithiohydantoin), 1-Aminocyclo pentanecarboxylic acid, Mealy plum aphid (Hyalopterus pruni), Prunus cerasifera.

INTRODUCTION

The Mealy plum aphid (*Hyalopterus pruni*) is a typical pest that infests plants of *Prunus spp.*, mainly plums, but also peaches, apricots and almonds. When infestation occurs on young leaves in large numbers, it can cause significant feeding damage combined with excreting honeydew onto lower leaves which become dark with sooty moulds that grow in the resulting sticky film. These fungi reduce the plant's ability to photosynthesize. *Hyalopterus pruni* is also a vector of plum pox potyvirus (PPV) [1].

In the current study we investigate the insecticidal action of cyclopentanespiro-5hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin) and 1-aminocyclopentanecarboxylic acid towards Mealy plum aphid as well as the effect of these substances on the main infected plant species - *Prunus cerasifera*, an appreciated widespread plant in Bulgaria of economic significance.

EXPERIMENTAL

Synthetic compounds

The cyclopentanespiro-5-hydantoin (Fig. 1, a) was synthesized *via* the Bucherer-Lieb method [2]. The cyclopentanespiro-5-(2,4-dithiohydantoin) (Fig. 1, b) was synthesized in accordance with Marinov et al. [3]. The 1-aminocyclopentanecarboxylic acid (Fig. 1, c) was obtained in accordance with Stoyanov and Marinov [4].

The products obtained were characterized through physicochemical parameters, IR and NMR spectral data. The results obtained from these analyses are identical with those previously published in the literature [4-6].



Saturated concentrations of the compounds in water were as follows: CPSH – 1 %, CPSDTH – 0.025 %, ACPCA – 0.1 %.

In vivo tests

A branch of *in vivo* insecticidal test [7] was performed in order to establish the insecticidal activity of tested compounds and their effect on infested plant species.

Ten different concentrations were tested to determine LC_{05} (NOEL), LC_{25} (LOAEL), LC_{50} and LC_{90} . Each test variant consisted of five replications. The individuals of each variant were sprayed with a solution of the tested product in the tested concentration by using a laboratory sprayer with a delivery rate 1000 I ha⁻¹. Mortality was observed after 24 and 48 h. Effectiveness was calculated using Abbott's formula [8].

The data received from the tests conducted was statistically manipulated with R language for statistical computing [9] and drc R language package [10].

Standard phytotoxicity tests were conducted in accordance with OECD Guide 227 -Terrestrial Plant Test: Vegetative Vigour Test [11]. The test period was 7 days. The plants were weekly observed for visual phytotoxicity manifestations (necrosis, chlorosis, whitening, deformations). On this basis, Percentage Disease Indexes (PDIs) were calculated in a 5-grade scale [12]. Based on the PDIs, LC_{05} (NOEL), LC_{25} (LOAEL), LC_{50} were determined through the use of R language and drc package. The chemotherapeutic indexes were calculated as a ratio between LC_{50} obtained from phytotoxicity test and LC_{90} obtained from insecticidal test.

RESULTS AND DISCUSSION

The spirohydantoins mentioned above were chosen for the current study due to their biological activity [3, 13, 14]. Furthermore, complex compounds based on cyclopentanespiro-5-hydantoin and its dithioanalogue have been synthesized to investigate their potential biological or other properties [15, 16].

The dose-response curves from the insecticidal tests conducted with the compounds (CPSH, CPSDTH and ACPCA) are depicted on figures 2 to 4.



Hyalopterus pruni, CPSH compound



Established toxicological indicators of CPSH are:

- 1. NOAEL (No Observed Adverse Effect Level) LC₀₅ = 0.031 %;
- 2. LOAEL (Lowest Observed Adverse Effect Level) LC₂₅ = 0.042 %;
- 3. LC₅₀ = 0.052 %;
- 4. LC₉₀ = 0.075 %.





- Established toxicological indicators of SPSDTH are:
- 1. NOAEL (No Observed Adverse Effect Level) LC₀₅ = 0.00012 %;
- 2. LOAEL (Lowest Observed Adverse Effect Level) LC₂₅ = 0.00027 %;
- 3. LC₅₀ = 0.00047 %;
- 4. LC₉₀ = 0.0011 %.

Hyalopterus pruni, ACPCA compound





Established toxicological indicators of ACPCA are:

- 1. NOAEL (No Observed Adverse Effect Level) LC₀₅ = 0.0007 %;
- 2. LOAEL (Lowest Observed Adverse Effect Level) LC₂₅ = 0.0017 %;
- 3. LC₅₀ = 0.002 %;
- 4. LC₉₀ = 0.007 %.

The trials conducted for phytotoxicity, as per infested plant *Prunus cerasifera*, reveal that in saturated concentrations in water, tested compounds do not manifest any deleterious effects.

Chemotherapeutic indexes obtained for the compounds are as follows: 13.33 for CPSH, 53.19 for CPSDTH and 14.28 for ACPCA.

The current study shows an excellent insecticidal action of cyclopentanespiro-5hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin) and 1-aminocyclopentanecarboxylic acid. The minimal effective concentration (LC_{90}) was between 0.0011 and 0.075 %. The standard used – Karate Zeon 5 CS with active substance Lambda cyalotrin (3A MoA), was effective against the aphid at 0.0015 % according to the active substance. LC_{90} of SPSDTH for example was 0.0011 %.

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ДИПЛОМА

РУСЕНСКИ УНИВЕРСИТЕТ "АНГЕЛ КЪНЧЕВ" UNIVERSITY OF RUSE "ANGEL KANCHEV"

> Програмният комитет на Научната конференция РУ&СУ'13 награждава с КРИСТАЛЕН ПРИЗ "THE BEST PAPER"

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In vivo инсектицидна активност на циклопентанспиро-5 хидантоин и две негови производни спрямо Прашеста сливова листна въшка (*Hyalopterus pruni*) ефект към *Prunus cerasifera*

DIPLOMA

The Programme Committee of the Scientific Conference RU&SU'13 Awards the Crystal Prize "THE BEST PAPER"to Donyo Ganchev, Marin Marinov, Milena Zlateva,Rumyana Prodanova, Angel Nikolov, Stefan Krustev,Neyko Stoyanov

authors of the paper

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