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ХИМИЧЕН КОНТРОЛ НА ОРАНЖЕРИЙНАТА БЕЛОКРИЛКА *TRIALEURODES VAPORARIORUM* (WESTWOOD) ПО *PELARGONIUM GRANDIFLORUM*

CHEMICAL CONTROL OF THE GREENHOUSE WHITEFLY, *TRIALEURODES VAPORARIORUM* (WESTWOOD) ON *PELARGONIUM GRANDIFLORUM*

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Abstract

The greenhouse whitefly *Trialeurodes vaporariorum* (Westwood) is an important polyphagous pest on various crops, which damages vegetables and flower plants.

The efficacy of some synthetic compounds: cyclohexanespiro-5-hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin), 4-(2-hydroxyethylimino)-cyclopentane-spiro-5-(2-thiohydantoin), cyclopentanespiro-5-(2-thiohydantoin) and 1-amino-cyclopentanecarboxylic acid in the control of second larval instars of the tested pest was investigated under laboratory conditions.

The structures of the compounds used were proven through physicochemical parameters, IR and NMR spectral data.

It was found that the 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin) manifests strong effectiveness towards the tested pest.

The mortality percentage of the larvae was calculated with the Abbott's formula and statistically analyzed by R language for Statistical Computing, drc package for Dose-Response evaluation.

Key words: *Trialeurodes vaporariorum*, insecticidal activity, chemical control, drc package, R language.

INTRODUCTION

The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) is an important polyphagous pest of various crops (Vet et al., 1980; Johnson et al., 1992). Adults and larvae produce major damages to vegetables and also to the flower plants by sucking the phloem sap from the leaves tissues and young offshoot, thus producing a honeydew, encouraging the growth of sooty molds and transmitting some plant viruses (Coffin and Coutts, 1995; Guzman et al., 1997). Chemical application is the common control technique of the pest *Trialeurodes vaporariorum* (Westwood) (Heungens and Buysse, 1990; Prijović et al., 2012). Insecticidal control is a difficult because the insect is resistant to most insecticides (Gorman et al., 2001). Furthermore, egg and the nonfeeding pupal stages are generally not susceptible to insecticides that can kill adults and nymphs. Thus repeated applications are usually required.

Thiamethoxam is a chloronicotinyl insecticide which is widely used to control homopteran pests (Elbert et al., 1998), and has been shown to have high efficacy against greenhouse whitefly (Bi et al. 2002). Salechi et al. (2013) found that the most effective insecticide for whiteflies is imidacloprid. It has systemic properties and is usually used as a soil application, taken into the plant via the roots. It is not registered for most home grown vegetables but can be used in flowerbeds and houseplants.

The aim of the current study is to evaluate the insecticidal activity of some synthetic compounds: cyclohexanespiro-5-hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin), 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin), cyclopentanespiro-5-(2-thiohydantoin) and 1-aminocyclopentanecarboxylic acid against second larval instars of the *Trialeurodes vaporariorum*.

MATERIALS AND METHODS

Synthetic compounds

All chemicals used were purchased from Merck and Sigma-Aldrich.

The cyclohexanespiro-5-hydantoin (Fig. 1) was synthesized *via* the Bucherer-Lieb method (Bucherer and Lieb, 1934). The cyclopentanespiro-5-(2,4-dithiohydantoin) (Fig. 2), the 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin) (Fig. 3) and the cyclopentanespiro-5-(2-thiohydantoin) (Fig. 4) were obtained in accordance with Marinov et al. (Marinov et al., 2005). The 1-aminocyclopentanecarboxylic acid (Fig. 5) was obtained according to Stoyanov and Marinov (Stoyanov and Marinov, 2012). The compounds 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 (Enchev et al., 1999; Marinov et al., 2005; Stoyanov and Marinov, 2012).

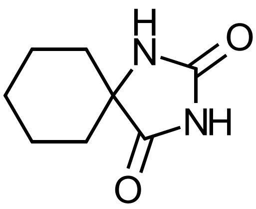

Fig. 1. *Cyclohexanespiro-5-hydantoin (CHSH)*
(Systematic name: 1,3-diazaspiro[4.5]decane-2,4-dione)

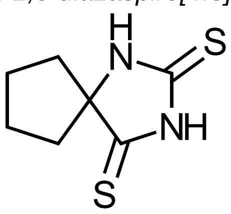

Fig. 2. *Cyclopentanespiro-5-(2,4-dithiohydantoin) (CPSDTH)*
(Systematic name: 1,3-diazaspiro[4.4]nonane-2,4-dithione)

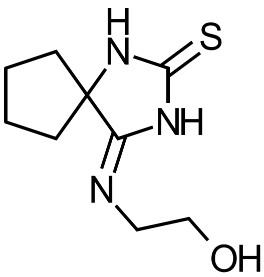

Fig. 3. *4-(2-Hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin) (HEICPSTH)*
(Systematic name: 4-[(2-hydroxyethyl)imino]-1,3-diazaspiro[4.4]nonane-2-thione)

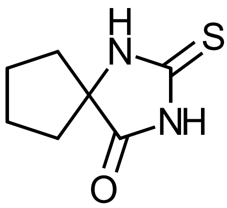

Fig. 4. *Cyclopentanespiro-5-(2-thiohydantoin) (CPSTH)*
(Systematic name: 2-thioxo-1,3-diazaspiro[4.4]nonan-4-one)

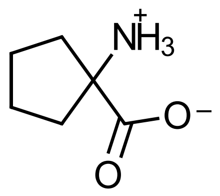

Fig. 5. *1-Aminocyclopentanecarboxylic acid (ACPCA)*

The concentrations of the compounds in water were as follows:

- cyclohexanespiro-5-hydantoin – 0.1 %;
- cyclopentanespiro-5-(2,4-dithiohydantoin) – 0.025 %;
- 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin) – 0.6 %;
- cyclopentanespiro-5-(2-thiohydantoin) – 0.06 %;
- 1-aminocyclopentanecarboxylic acid – 0.1 %.

Trialeurodes vaporariorum

The population of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) was established by infested flower plants *Pelargonium grandiflorum* and was grown under laboratory conditions (25 ± 2 °C, 50 ± 5 % RH and a photoperiod of 18:6 L/D). Laboratory bioassay was carried out under laboratory conditions (25 ± 2 °C, 50 ± 5 % RH and a photoperiod of 18:6 L/D) to evaluate the insecticidal activity of some synthetic compounds: cyclohexanespiro-5-hydantoin, cyclopentanespiro-5-(2,4-dithiohydantoin), 4-(2-hydroxyethylimino)-cyclopentane-spiro-5-(2-thiohydantoin), cyclopentanespiro-5-(2-thiohydantoin) and 1-amino-cyclopentanecarboxylic acid against second larval instars of the whitefly. IRAC Susceptibility № 16 for nymphs were used (IRAC, 2009). The mortality percentage of the larvae was recorded after 48 h, calculated with the Abbott's formula (Abbott, 1925) and statistically analyzed by R language for Statistical Computing (R Development Core Team, 2011), drc package (Ritz and Streibig, 2005) for Dose-Response evaluation.

RESULTS AND DISCUSSION

Conducted tests reveal that the following compounds: cyclohexanespiro-5-hydantoin (CHSH), cyclopentanespiro-5-(2,4-dithiohydantoin) (CPSDTH), cyclopentanespiro-5-(2-thiohydantoin) (CPSTH) and 1-aminocyclopentane-carboxylic acid (ACPCA) have no effect on the tested insects at the above cited concentrations in water. All individuals were alive without no visual symptoms of toxicity. However, the 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydan-toin) (HEICPSTH) shows strong insecticidal activity.

The Dose-Response Model of the latter is presented in Figure 6.

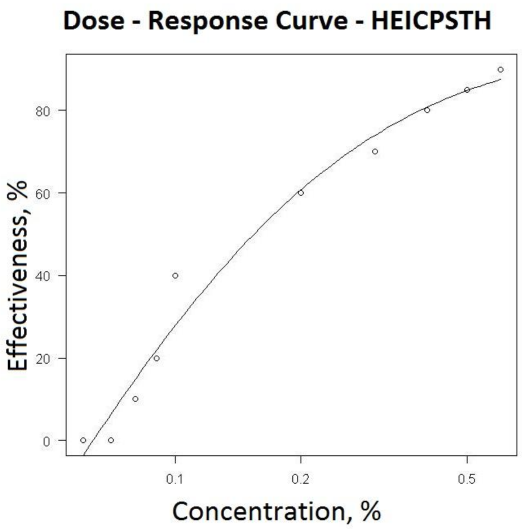

Fig. 6. *Dose-response curve of 4-(2-hydroxyethylimino)-cyclopentanespiro-5-(2-thiohydantoin) (HEICPSTH)*

The major toxicology values are:

- NOAEL = 0.05 %;
- LOAEL = 0.08 %;
- LD_{50} = 0.25 %;
- LD_{90} = 0.57 %.

The picture below shows the dead *T. vaporariorum* larvae due to the action of HEICPSTH compound with almost completely decayed bodies (Fig. 7). The pictures were taken with Chronos USB 2.0 digital microscope (100x).

Control variant HEICPSTH (0.6 %) treated variant

Fig. 7. *HEICPSTH treated variant*

CONCLUSIONS

1. The received results clearly manifest the insecticidal potential of the HEICPSTH compound and the possibility of its development as a synthetic insecticide in the future.

2. The active substance is dissolved in water and can be formulated as ready to be used solution which is great especially for small farms and people with limited skills in the area of pest management and pesticide science.

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