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PLANT PROTECTION

Evaluation of Effect of Insecticides on Beneficial Arthropods

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Abstract—This paper presents the results of evaluating the effect of such insecticides as imidacloprid, thiacloprid, chlorantraniliprol, and thiamethoxam on representatives of beneficial arthropods, including Miridae, Anthocoridae, Cecidomyiidae. The insect mortality was determined upon treatment with insecticides in recommended application rates. The results of laboratory and field studies of the effect of insecticides on beneficial arthropods are compared.

Keywords: entomophages, imidacloprid, thiacloprid, chlorantraniliprol, thiamethoxam

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INTRODUCTION

Formation of environmentally adapted systems of plant protection against hazardous organisms is possible only after the risk degree of pesticides for beneficial arthropods is evaluated. There are currently several developed systems of evaluating pesticides for environmental hazard. Studies by such researchers as G.I. Sukhoruchenko, K.V. Novozhilova, etc. [1–3] have made it possible to create a system of expert evaluation of pesticides for the degree of hazard to zoophages. This system includes data of laboratory, field, and combined lab-field tests and makes it possible to determine pesticides' hazard to a lot of zoophages species (lady bugs, chrysopidae, antocoridae, miridae, nabidae, syrphidae, etc.).

After the most prospective insecticides had been applied, we conducted preliminary observations of the rate at which entomophages would recover in number in potato agrobiocenosis. Our field tests have proven that imidacloprid, thiacloprid, thiametoxam, and chlorantraniliprol applied in recommended manners have a weak toxic effect on beneficial arthropods involved in potato agrobiocenosis, because they do not produce a strong effect on the size of such dominant entomophage species as *Coccinella septempunctuata* L. (*Coleoptera*, *Coccinellidae*), *Chrysopa carnea* Steph. (*Neuroptera, Chrysopidae*), *Syrphidae* (*Diptera*) flies, *Anthocoraidae* (*Hemiptera*) bugs *Aphidiidae* (*Hymenoptera*) wasps, spiders (*Araneae*); soil biota orders such as *Collembala* and *Coleoptera* (*Carabidae* fam., *Falokoridae* fam.), *Lepidoptera*, *Diptera*, and *Thysanoptera,* as well as *Oribatei* (p/k Akari). The original population size of beneficial microorganisms was recovered in 7–14 days [4–6].

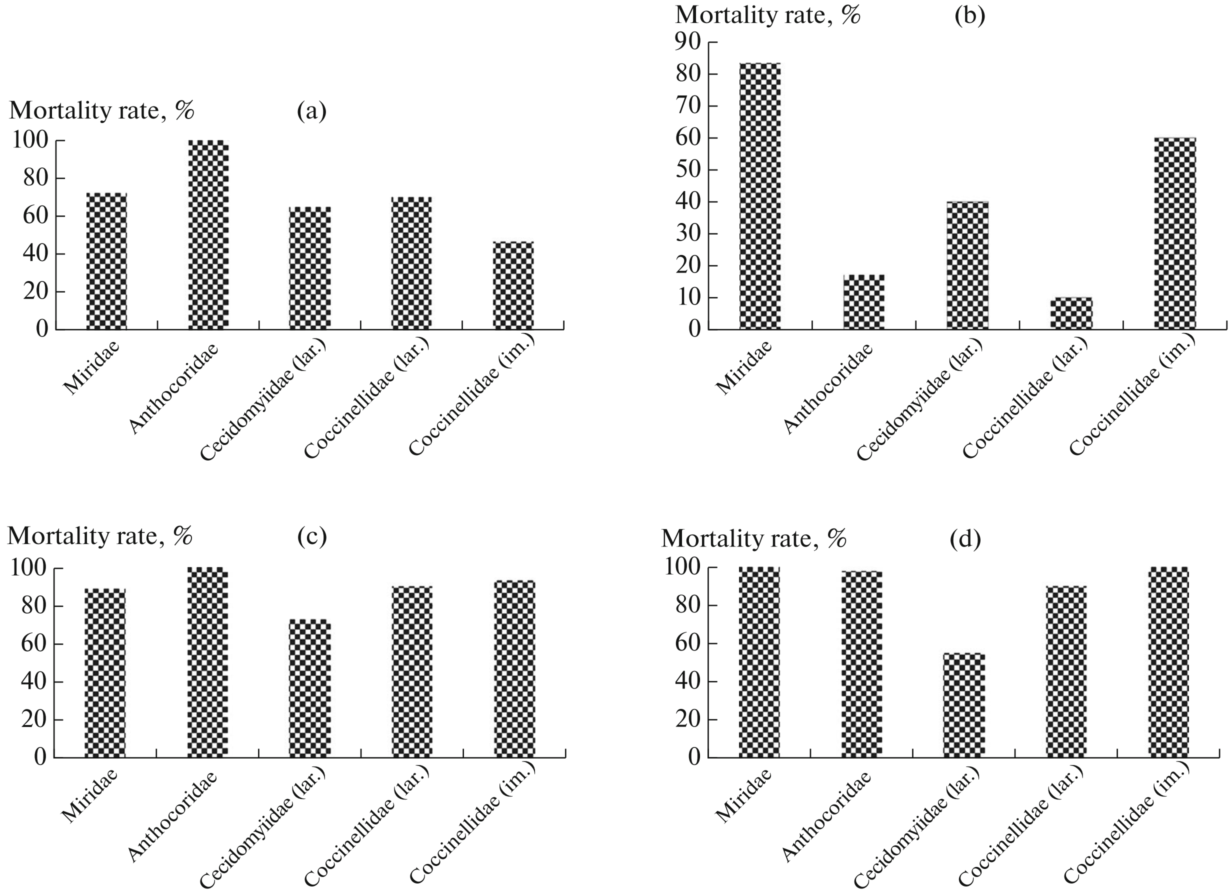
The goal of this paper was to study in the laboratory the effect of such insecticides as imidacloprid, thiacloprid, chlorantraniliprol, and thiamethoxam on beneficial insects.

METHODS

The lab tests were conducted according to the Methodic Guidelines for Procedures of Environmental Safety Evaluation of Pesticides Used in Integral Plant Protection [1] with the following rules observed: apply the insecticides only at recommended production concentrations, distribute the preparation smoothly, use test objects evened by age and phase of development and taken from laboratory cultures, ensure equal exposure periods, observe water control (treatment with water). The preparations were evaluated for toxicity on arthropod test objects on the basis of mortality rates (%) along a 4-point scale [3]: 1, 2, 3, and 4 points mean the mortality rate of <10 (nonhazardous preparation), 11–50 (low-hazardous preparation), 51–70 (averagely hazardous preparation), and >70% (hazardous preparation), respectively. The mortality rate was found using the Abbot equation.

The test objects were *Miridae*, *Anthocoraidae*, and *Cecidomyiidae* larvas, as well as imago larvas of *Coccinellidae* taken from laboratory populations.

The test material included the following insecticides: imidacloprid (Konfidor Extra in water-dispersable granules (WDGs) (700 g/kg) with a standard applied amount of 0.2 kg/ha; thiacloprid (Vizckaya oil



Mortality rate of entomophages one day after insecticide processing of (a) imidaclopridae with (b) chrolantraniliprol, (c) thiamethoxam, and (d) thiamethoxam + chrolantraniliprol; l—larvas; im.—imago.

dispersion (OD) (240 g/L) applied at 0.3 L/ha; chlorantraniliprol (Koragen suspersion concentrate (SC) (200 g/L) applied at 0.05 L/ha; thiametoxam (Aktara, WDGs (250 g/kg) applied at 0.08 kg/ha, and thiametoxam + chlorantraniliprol (Voliam Flexi suspension concentrate (SC) (200 + 100 g/L) applied at 0.4 L/ha.

Like all neonicotinoids, imidacloprid, thiacloprid, and thiamethoxam act by blocking protein receptors of insects' neurons, which makes neural pulses impossible and leads to paralysis and death. Chrolantraniliprol breaks the calcium balance in insects' muscular fibrillas and activates rhynidine receptors, leading to depleted calcium reserves, intensified muscular contraction, and death [7]. Each test variant is repeated three times (20 insect specimen per each repeated test). The test data were recorded on the first, third, fifth, seventh, and tenth days after the treatment.

RESULTS AND DISCUSSION

The lab tests have proven that imidacloprid is low hazardous to Coccinellidae imagoes, averagely hazardous to Cecidomyidae, and hazardous to Anthocoridae and Miridae (Fig. 1a). Thiacloprid is averagely hazardous to Cecidomyidae and Coccinellidae (the mortality rate 1 day after the treatment was 67.5–70.0%) and hazardous to bug larvas and Coccinellidae imago larvas (>80.0%). Chlorantraniliprol appeared to be nonhazardous to Coccinellidae, low hazardous to Anthocaridae and Cecidomyidae, averagely hazardous to Coccinellidae imago larvas, and hazardous to Miridae larvas (Fig. 1b).

The effect of thiametoxam was fatal for all the test objects (Fig. 1c). It is interesting that the low-hazardous chlorantraniliprol combined with the hazardous thiametoxam becomes hazardous to all the test objects (averagely hazardous to Cecidomyidae larvas) (Fig. 1d).

Thus, our tests make it possible to evaluate in the laboratory the direct impact of efficient insecticides on beneficial insects. In our opinion, the evaluation of environmental impact of pesticides requires their field testing, when the effect of preparations on entomophages may appear not so severe and the recovery at which beneficial insects recover to their original size will make it possible to classify these preparations as non- or low-hazardous [4–6].

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