TOXICITY PESTICIDES USED IN GREENHOUSES AND PROMISING FOR PREDATORY MITE NEOSEIULUS BARKERI (MESOSTIGMATA: PHYTOSEIIDAE)

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Abstract. A type of a phytoseiid mite Neoseiulus barkeri Hughes, acclimatized in industrial greenhouses on the cucumber culture (of Matveevsky, Moscow region) has been identified in protected soil on the territory of the Russian Federation. The key factor of successful survival of this population in protected cultivation perhaps should be considered the formation of mite resistance to some pesticides used in greenhouses. In particular, to avermectin pesticides, which have been occupying a leading position for more than 20 years in the protected soil of Russia. According to the classification of pesticides side effects on organisms used in biological protection, such pesticides as Confidor Extra, Nocturne are considered to be low-risk. They cause the mortality of predatory mite N. barkeri females, not exceeding 25%. The most promising from our point of view is the safest acaricide Scelta (mortality of females at the recommended rate of 4,4%). Therefore, these pesticides may be recommended for use in combination with the predatory mite N. barkeri when introducing environmentalized/green programs of integrated control of the number of dangerous species of harmful arthropods under conditions of protected soil.

1. Introduction

Phytoseiidae have been used successfully as bio-control agents of pests worldwide. Neoseiulus barkeri Hughes, 1948 (Mesostigmata: Phytoseiidae) is a specialized predator of various harmful arthropod species (Insecta, Arachnida). In world practice it is important as an a highly effective entomophage of thrips first of all [1, 2]. On the other hand, N.barkeri exhibits the properties of acariphage [3,4].

In favorable hygrothermic conditions, greenhouse crops are prone to outbreaks of plant-eating mites and insects. In this regard, the most important method for plant protection in traditional farming is the use of pesticides. In order to regulate the number of common spider mite Tetranychus urticae, one of the key greenhouse pests, as well as to suppress populations of various harmful insects, acaricides and insecticides of chemical or biological synthesis are widely used. The interaction of various plant protection products is important for solving the practical problem of controlling the number of herbivorous arthropods. One aspect of its solution is to assess the toxic effects of pesticides on non-
target objects, especially on entomophages and acariphages. To determine its definition, a special scale of lethal effects on entomophages and acariphages in various developmental stages has been introduced [5]. At the beginning of the century in Russia greenhouses avermectin pesticides, for example, Vertimec, EC (abamectin, 18 g/l), Fitowerm, EC (aversectin C, 2 g/l) were allowed for use against a complex of pests (mites, thrips, whiteflies, aphids). In the world practice, pesticides based on abamectin are the most widely used. In this regard, its toxicity to predatory mites from the Phytoseiidae family has been repeatedly assessed [6,7]. Abamectin was classified as “slightly harmful” (8) or as moderately dangerous pesticides (mortality within 30...79 %), [9]. Neonicotinoids have different lethal effects on predatory mites. It has been established that in relation to the predatory mite N. barkeri high toxicity of acetamiprid is significantly lower than thiacloprid [10].

To regulate the number of sucking phytophages (whiteflies, thrips) widely use low toxic pesticides that have the properties of the juvenile hormone, in particular on the basis of pyriproxyfen [10]. The use of pyrethroids, as well as organophosphorus pesticides, inevitably leads to the mass death of natural enemies of crop pests. A practical way to balance pesticides and biological control by reducing the side effects of chemical agents is constant screening of resistance of predatory mites. In breeding works the fenpropathrin resistant N. barkeri strain was obtained with a resistance ratio of 620 fold. The formation of resistance to fenpropathrin was accompanied by many genetic changes. The analysis showed that the N. barkeri mite strain achieved a high level of resistance to pyrethroids by increasing detoxification rate of the P450s and glutathione S-transferase (GSTs) and decreasing susceptibility of the target site (sodium channel) simultaneously [11].

On the basis of the information search, a conclusion was made on the varying degrees of influence of broad-spectrum insecticides, specific acaricides and selective insecticides on the predatory mite N. barkeri. However, the toxic effects of some pesticides appearing on the world market in recent years have not been sufficiently covered.

In connection with the foregoing, the purpose of our study is to determine the potential use of N. barkeri akariphage against the background of chemical treatments greenhouse pests.

2. Methods and materials
We used the predatory mite population of the Neoseiulus barkeri Hughes collected in 2017 (Matveevsky, Moscow region) on the greenhouse cucumber plants Mayova F1 in low-volume cultivation technology. Presumably a mite is adapted to the living in production conditions against the background of the avermectin press.

In the laboratory, the direct effects of three pesticides groups on N. barkeri were assessed for predatory mites: previously used Actellic, EC (pyrimiphos-methyl 500 g/l) is included in the test pesticide as a reference; currently used - Fitoverm, EC (aversectin C, 2 g/l), Novaction, WE (malathion, 440 g/l), Confidor Extra, WDP (imidacloprid, 700 g/kg); promising for use - Proclaim, WSP (emamectin benzoate, 50 g/kg), Scelta, SC (cyflumetofen, 20 g/l), Nocturne, SC (pyridalyl, 100 g/l), Oberon, SC (spiromesifen, 240 g/l).

We used the manufacturer’s recommended concentration of the pesticides (T), half concentration (1/2 T), in some cases, double concentration (2 T). This methodical approach allows us to assess the effects/consequence of pesticide use on useful entomophauna [12,13]. In the experiment, about 20-30 predatory mite females were placed on the isolated double-leaf bean plants with a two-spotted spider mites. Then plants were submerged for 3 seconds in water solution of pesticides of certain concentrations or in water (control). The females mortality was checked after 48 hours. The experiments were carried out in four replay.

3. Results and discussion
These results showed that different groups of pesticides differed significantly in their toxicity to adult females N. barkeri. It is important: the females survived after being treated with some pesticides (Table 1).
Table 1. The extent of pesticide exposure to *Neoseiulus barkeri* females

| Pesticides used in greenhouses         | Content of active ingredients, mcg/ml | Field recommended concentrations rates | Predatory mite females | Mortality rate (X_{cp}±S_{i}), % |
|----------------------------------------|--------------------------------------|---------------------------------------|------------------------|----------------------------------|
|                                        |                                      |                                       | Original number in experience (N_0) | Total number of dead individuals (N_1) |
| Pesticides with names, groups, active ingredients (AI) | | | | |
| Fitoverm (aversectin C, 2 g/l) | 1,0 | 20 | 146 | 9 | 93,7±6,7 |
|                                        | 0,2 * | 10 | 208 | 68 | 33,1±8,8 |
|                                        | 0,1 | 5 | 154 | 27 | 16,3±3,2 |
| Confidor Extra, WDP (imidacloprid, 700 g/kg) | 0,015 * | 105 | 102 | 23 | 21,7±4,0 |
|                                        | 0,0075 | 525 | 89 | 16 | 18,2±3,7 |
| Actellic, EC (pirimiphos-methyl 500 g/l) | 0,2 | 1000 | 217 | 86 | 39,5±4,7 |
|                                        | 0,1 * | 500 | 260 | 65 | 24,8±5,4 |
| Novaction, WE (malathion, 440 g/l) | 0,15 * | 660 | 66 | 49 | 42,1±7,3 |
|                                        | 0,075 | 330 | 172 | 38 | 20,7±11,5 |
| Promising pesticides for use in greenhouses | | | | | |
| Scelta, SC (cyflumetofen, 20 g/l) | 0,2 | 40 | 104 | 7 | 6,9±3,1 |
|                                        | 0,1 * | 20 | 106 | 7 | 4,4±0,8 |
|                                        | 0,05 | 10 | 79 | 4 | 5,4±3,8 |
| Nocturne, SC (pyridalyl, 100 g/l) | 0,1 * | 100 | 404 | 86 | 23,0±8,3 |
| Proclaim, WSP (emamectin benzoate, 50 g/kg) | 0,2 | 100 | 158 | 111 | 70,5±3,1 |
|                                        | 0,1 * | 50 | 151 | 62 | 40,7±4,0 |
| Oberon, SC (spiroimesifen, 240 g/l) | 0,05 * | 120 | 136 | 55 | 42,2±9,8 |
| Control (water) | - | - | 352 | 20 | 6,3±5,3 |

*Note:* *– pesticide concentration in water solution recommended by manufacturer of pesticide.*

Pesticide based on aversectin C Fitoverm at manufacturer's recommended and halved concentrations showed a moderate toxic effect on females of the studied population (respectively 33, 1 and 16,3%).

The neonicotinoid insecticide Confidor Extra also had a moderate toxic effect on females at all the concentrations tested. Treatment with the pesticide in the manufacturer's recommended concentration led to the death of 21,7% of females.

Moderately toxic effect on predatory mite *N. barkeri* also had organophosphorus pesticide Actellic. Treatment with the pesticide in the manufacturer's recommended concentration led to the death of about 25% of females. When the pesticide concentration was doubled, the mortality of females increased only by 1,6 times.

The organophosphorus pesticide Novaction was more toxic for mite females. At the recommended concentration, about 42% of females died, while the concentration was halved, the mortality rate was also reduced by almost two.
Among the pesticides promising for use in protected soil, acaricide Scelta based on cyflumetofen was least harmful for *N. barkeri*. Scelta caused the lowest females mortality. Regardless of its concentration in the working solution, the mortality of female mites was within 4.4... 6.9%.

Present findings revealed that moderate toxicity for female mites was shown by the insecticide Nocturne on the basis of a new class of chemical compounds, one of the derivatives of pyridalyl (mortality of females 23%).

The pesticides Proclaim and Oberon showed relatively high toxicity in relation to the predatory mite *N. barkeri*. The avermectin insecticide Proclaim at the recommended concentration caused a mortality rate of 42.2% of females. With a halved concentration, females mortality was reduced by more than four times.

Treatment of *N. barkeri* females with the recommended concentration of Oberon insectocaricide based on spiromesifen resulted in the death of more than 40% of individuals, with a halved concentration, females mortality was decreased by 1.6 times.

### 4. Conclusion

A type of a phytoseiid mite Neoseiulus barkeri Hughes, acclimatized in industrial greenhouses on the cucumber culture (of Matveevsky, Moscow region) has been identified in protected soil on the territory of the Russian Federation. The key factor of successful survival of this population in protected cultivation perhaps should be considered the formation of mite resistance to some pesticides used in greenhouses. In particular, to avermectin pesticides, which have been occupying a leading position for more than 20 years in the protected soil of Russia.

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