INSECTOACRICIDES AND INSECTICIDES AND NEOSEIULUS CALIFORNICUS (PARASITIFORMES, PHYTOSEIIDAE) SAFE AND GREAT APPLICATION IN PROTECTED GROUND

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Abstract. Toxicity study for predatory mites Neoseiulus californicus pesticides legally permitted for use against pests (aphids, thrips, whiteflies) in the Russian Federation on protected ground is an urgent task. The purpose of determining the possibility of safe use of chemical treatments with drugs (Vertimeca (abamectin), Clipper (bifenthrin), Novaktion (malathion), Admiral (pyriproxyfen), Aktara (thiamethoxam), Confidor (imidacloprid) and Bitoxibacillin (Bacillus thuringiensis var. thuringiensis) against the background of the acariphagus.

1. Literature review
Toxicity study for predatory mites Neoseiulus californicus pesticides legally permitted for use against pests (aphids, thrips, whiteflies) in the Russian Federation on protected ground is an urgent task. The purpose of determining the possibility of safe use of chemical treatments with drugs (Vertimeca (abamectin), Clipper (bifenthrin), Novaktion (malathion), Admiral (pyriproxyfen), Aktara (thiamethoxam), Confidor (imidacloprid) and Bitoxibacillin (Bacillus thuringiensis var. thuringiensis) against the background of the acariphagus. Phytoseid mite Neoseiulus californicus (McGregor) is a specialized predator of many economically significant species of spider mites (Acariformes, Tetranychidae). In protected ground Neoseiulus californicus used on vegetable and ornamental crops to protect against spider mites Tetranychus urticae Koch [1,2]. In the absence of a phytophage, it can survive by feeding on larvae of thrips, whiteflies, and even plant pollen [3].

Common spider mite Tetranychus urticae (Koch) – one of the key pests in greenhouses. The regulation of its number is carried out mainly with the help of acaricides of chemical or biological synthesis. Such means of protection as plant extracts, entomopathogenic fungi and predatory mites are put forward as safer for the ecological situation. It has been experimentally established that pathogenic fungi Beauveria bassiana and Paecilomyces fumosoroseus, as well as plant extract (pepper-garlic) did not have a lethal effect on phytoseid, but reduced their fertility [4].

The use of pesticides in the framework of IPM programs, selectivity is one of the main requirements, safety is not always the case. For example, the systemic neonicotinoid imidacloprid is used to suppress whiteflies and aphids, but this insecticide does not affect spider mite mortality. For the regulation of
tetranychid mites, it is advisable to use predatory mites, in particular Ph. persimilis и N. californicus. However, imidacloprid sometimes affects some of the demographic indicators of phytoseid [5].

Spiromesifene showed the least toxicity to predatory mites N. californicus, than many acaricides, it began to be used for the integrated management of the number of spider mites in combination with predatory mites [6]. However, many acaricides do not show direct toxicity to predatory mites (all stages of development survived from biphenazate N. californicus, females retained a normal level of fertility, even if the females were fed with treated spider mite eggs [7].

The smallest aftereffect in relation to the predatory mite N. californicus has been identified for abamectin. Propargite and dimethoate on the 14th day caused 30% mortality of predatory ticks, while 23% of predators died from the residual action of bifenthrin and on the 21st day [8]. Deltamethrin tolerant to treatments was found to be N. californicus compared to tick Phytoseiulus macropilis (Banks) [9].

Acaricides based on cyenopyrafene, spirodiclofen, spiromesifene, flufenoxuron and cyflomethaphene showed low toxicity for females and nymphs of the predatory tick N. californicus. Also, a slight decrease in reproductive function was noted, including with the use of seed treatment with preparations with during the development of pest populations from soil overwintering in open or sheltered plots used in Russia by farmers, personally subsidiary farms [10; eleven]. These preparations did not affect the fertility of females fed on spider mites treated with acaricides. It was shown that pesticides based on ethoxazole, which significantly reduces the fertility of predatory mites, and pyraclophos, which causes 100% mortality of females, cannot be used in an integrated protection system [10].

The acaricides acequinocyl, ethoxazole, milbemectin and biphenazate are highly toxic to the eggs of predatory mites Ph. persimilis and N. californicus(on the 7th day after treatment, the mortality of nymphs and adults increased significantly). The pesticides used against spider mites are recommended by us for use in agricultural areas with caution [12].

Highly toxic for N. californicus proved to be organophosphorus drugs, in particular, dimethoate and pyrethroids (permethrin, cypermethrin, fenvalerate, etc. [13]. Pride (phenazquine) and Envidor (spirodiclofen) increase the duration of preimaginal development, and also reduce the reproductive period by 1.6 times and almost 3 times reduce the fertility of females N. Californicus [14].

2. Methodology

In this study, the population of the predatory mite was used N. californicus from the greenhouse of the state farm "Pervomaisky" (GBU "Ozelenie", Moscow). Presumably, this population is adapted to living in industrial conditions against the background of pesticide pressure.

The cultivation of predatory mites was carried out under laboratory conditions. Breeding cycle N. californicus consists of three main stages: growing bush bean plants, populating them with a forage mite T. urticae and a predator, collecting acariphage for toxicological experiments. Uterine culture N. californicus and the food mite were kept in parallel in different rooms on illuminated racks at a temperature of 22-26 °C, a relative humidity of 60% and a day length of 18-20 hours.

Under laboratory conditions against predatory mites N. californicus an assessment of the direct action of pesticides used in protected ground in the Russian Federation was carried out: Vertimeka, CE, 18 g / l (abamectin), Clipper, CE, 100 g / l (bifenthrin), Novaktion, VE, 440 g / l (malathion), Admiral, EC, 100 g / l (pyriproxyfen), Aktara, VDG, 250 g / kg (thiamethoxam), Confidora Extra, VDG, 700 g / kg (imidacloprid), Bitoxibacillin, P, BA-1500 EA / mg, (Bacillus thuringiensis var. thuringiensis).

Investigated the recommended production concentration of the drug (T), half concentration (1/2 T) and double concentration (2 T), according to the guidelines [2; 3], this makes it possible to assess the consequences of the use of pesticides on the beneficial entomofauna and the environment.

To study the effect of pesticides on the phytoseid, one day before treatment, isolated two-leaved bean plants with spider mites were inoculated with females of a predator, 20-30 individuals per leaf. Plants were immersed for 3 sec. into aqueous solutions of the tested drugs of a certain concentration or into water (control). Then the shoots were placed in glass containers with water, securing the cut plants.
After the treatment, it was necessary to ensure the possibility of feeding the surviving females of the predator. For this purpose, additional spider mites were placed on the dried leaves after immersion in the pesticide solution using a soft brush. The experiments were carried out in four repetitions.

The death of phytoseid mites was assessed one day after treatment with organophosphate insectoacaricides, three days after treatment with avermectins and neonicotinoids, and 5 days after treatment with bitoxybacillin.

3. Results

Table 1 presents the results of studies on the effect of predatory ticks on females *N. californicus* norms of insectoacaricides and insecticides legally permitted for practical use in the Russian Federation.

Vertimek and Clipper showed high toxicity for females of predatory ticks - 100% mortality of females was established *N. californicus* preparations based on milbemectin) [11; 12].

An insignificant effect on the mortality of females was exerted by: Novaktion, Bitoxibacillin, Aktara, Admiral (mortality of females in the range from 16.6% to 2.2%). Non-toxic under these conditions for the Confidor tick (imidacloprid) - female mortality is 0%.

| No | Trade name of the drug, classification | Active ingredient, content | Application concentration, % | Mortality of female predatory mites, % |
|----|--------------------------------------|----------------------------|-------------------------------|---------------------------------------|
| 1  | Vertimek CE insectoacaricide          | abamectin, 18 g/l          | 0.025                         | 99.5 c                                |
|    |                                      |                            | *0.05                         | 100 c                                 |
|    |                                      |                            | 0.1                           | 100 c                                 |
| 2  | Clipper CE insectoacaricide           | bifenthrin, 100 g/l        | 0.03                          | 83.0 b                                |
|    |                                      |                            | *0.08                         | 100 c                                 |
|    |                                      |                            | 1.0                           | 100 c                                 |
| 3  | Novaktion VE insectoacaricide         | malathion, 440 g/l         | 0.08                          | 6.7 a                                 |
|    |                                      |                            | *0.15                         | 16.6 a                                |
|    |                                      |                            | 0.3                           | 35.4 a                                |
| 4  | Bitoxibacillin P insectoacaricide     | БА-1500 EA/mg *B.thuringiensis* | 0.5                          | 3.3 a                                 |
|    |                                      |                            | *1.0                          | 12.6 a                                |
|    |                                      |                            | 1.5                           | 33.2 a                                |
| 5  | Aktara EDG insecticide                | thiamethoxam, 250 g/kg     | 0.05                          | 1.5 a                                 |
|    |                                      |                            | *0.08                         | 11.2 a                                |
|    |                                      |                            | 1.0                           | 24.9 a                                |
| 6  | Admiral KE insecticide                | pyriproxyfen, 100 g/kg     | 0.01                          | 0 a                                   |
|    |                                      |                            | *0.02                         | 2.2                                   |
|    |                                      |                            | 0.04                          | 10.9 a                                |
| 7  | Confidor EDG insecticide              | imidaclorpid, 700 g/kg     | 0.008                         | 0 a                                   |
|    |                                      |                            | *0.015                        | 0 a                                   |
|    |                                      |                            | 0.03                          | 1.0 a                                 |
| 8  | Control                               | -                          | 0                             | 0 a                                   |

* Recommended pesticide concentrations in Russia
Mean values in columns followed by different letters are significantly different (t-Student’s test)

These pesticides deserve the most attention from a practical point of view when investigating the potential for effective use in greenhouses of an ecologically safe plant protection product, the predatory mite *N. californicus* against the background of chemical treatments against pests.
According to the classification of the side effects of pesticides on beneficial organisms used in biological protection [15], drugs: Novaktion, Bitoxibacillin, Admiral, Aktara, Confidor are harmless (cause mortality of female predatory tick \( N. \text{californicus} \), < 25 % with intensive processing of vegetable and ornamental crops). That's why? these pesticides can be included in combination with predatory mites \( N. \text{californicus} \) into ecologized programs of integrated management of the number of dangerous species of harmful arthropods in protected ground conditions. It should be noted that adaptively integrated plant protection [16; 17; 18] is more effective when used by production workers in covering and open production of vegetables in the fight against whitefly, harmful arthropods, in the case of equalizing phytosanitary burst crops of types of strategic crops (wheat, sunflower) as applied in the fight against prickly-sucking pests (aphids, thrips, etc.) [17; eighteen; 19], as well as an increase in the ecological soil index based on a decrease in pesticide load [19; twenty]. The peak of the vertical production of organic vegetables turned to the production of salads in a short period of time, with the impossibility of protecting against pests and exceeding the maximum permissible concentration (MPC) doses in the products obtained by the example of China [21; 22], in a number of countries such programs have switched to semi-legal production, saving on protective technologies and the health of consumers of products.

In most countries, it is legally provided as a result of soil pollution (requiring subsequent disposal, toxicity from the use of pesticides) and consequences in the form of harm to human health (exceeding the maximum permissible concentrations of pesticides) or the environment is subject to criminal prosecution. At the same time, not all national laws of foreign states contain separate norms providing for criminal liability for damage or pollution of land [23, 24, 25, 26]. The legislators of such countries have provided for liability for the violations under consideration in the framework of the administrative or environmental branches of law.

4. Conclusions
It is necessary to take into account the experience of China in the economic default of vertical (urban phyto-farms) under the influence of pests from obtaining products that exceed the maximum permissible norms of pesticides. It is promising to conduct research on the possibilities of plant protection in action and aftereffect as a goal of reducing the pesticide load (toxicity of drugs, their doses, the possibility of biologization by using in combination with predators). It is important to control the use of insecticides insectoacaricides within the territorial limits of urbanized areas to limit the possibility of manifestation of resistant varieties of pests of agricultural and ornamental crops. According to the results of the study, it is clear that it is impossible to release the tick \( N. \text{californicus} \) against the background of the use of bifenthrin (which is more effective to use with a high number of harmful arthropods). With a subthreshold number of pests, it is necessary to use releases of predatory mites, if the threshold number is exceeded, releases of predatory mites together with pesticides non-toxic to phytoseid.

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