Efficacy of Bioinsecticides against the Hop Aphid *Phorodon Humuli* (Schrank) (Hemiptera: Aphididae) under Laboratory Conditions

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ABSTRACT

The efficacy of three bioinsecticides: the microbial Naturalis (*Beauveria bassiana*) and the botanical Pyrethrum FS EC (pyrethrin + sesame oil + soft potassium soap) and NeemAzal T/S (azadirachtin), allowed for application in organic farming in Bulgaria, against the hop aphid *Phorodon humuli* Schrank were studied under laboratory conditions. The best results from the tested products showed microbial insecticide Naturalis (*Beauveria bassiana*). At a concentration of 0.2% the efficacy reached 46% on the 3-rd day, 70.3%, on the 5-th day and 91.5% on the 7-th day after the treatment. The preparation showed very good action in its low concentration (0.1%) – efficacy was over 65% on the 5-th day and 79.8% on the 7-th day after the treatment. Insecticides based on plant extracts showed not very good efficacy against *P. humuli*. The Pyrethrum insecticide, based on natural pyrethrins showed better action than azadirachtin based product NeemAzal T/S. The efficacy of Pyrethrum on the 7-th day after the treatment reached 86.9% at concentration 0.1% and 75.8% at lower concentration of 0.05%. The weakest action showed NeemAzal T/S. The efficacy was only 67.6% and 61.6% at concentration 0.5% and 0.3%, respectively.

Keywords: *Bioinsecticides, Phorodon humuli, Beauveria bassiana, Naturalis, Pyrethrum FS EC, NeemAzal T/C.*

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Highlights of this paper

- In recent years with development of the organic agriculture in our country has been increased interest in bioinsecticides as alternatives to chemical products.
- Three bioinsecticides suitable for control of aphids have been registered in Bulgaria: Naturalis, Pyrethrum FS and NeemAzal T/S.
- The P. humuli is the third most common aphid species of plum and cherry plum in Bulgaria and the present study aimed to establish the efficacy of these three bioinsecticides against the hop aphid Phorodon humuli Schrank under laboratory conditions.

1. INTRODUCTION

The hop aphid *Phorodon humuli* (Schrank) (Hemiptera: Aphididae) was reported in 1801 by Schrank. The species is a migratory holocyclic, with major hosts *Prunus domestica*, *P. instititia*, *P. spinosa*, *P. cerasus*, *P. padus*, *P. machaleb* and *P. avium*. The only reported secondary host is the hop (cultural and wild) *Humulus spp.* [1, 2].

P. humuli is the third most common aphid species of plum and cherry plum in Bulgaria. It was found in more than half (80) of the surveyed 143 municipalities. The highest density of the aphid (more than 50% infestation on shoots) was found in the municipality of Sadovo, Plovdiv district [3].

The pest has a preference for the cherry plum and attacks only some varieties of plums, but usually, it has high population density and can cause premature fall of the leaves of infested shoots, although it does not cause leaf-curling and deformations Figure 1.

Figure-1. *Phorodon humuli* – colony of apterous forms (a) and alate aphid (b).

Pavlin Vasilev original photos.

The farmers usually control *P. humuli* with use of system-acting chemical insecticides. This has stimulated the development of resistant aphid genotypes within the plum- and hop-growing regions [4]. In recent years with development of the organic agriculture in our country has been increased interest in bioinsecticides as alternatives to chemical products. The bioinsecticides are important component in modern plant protection, because they are selective and relatively safe for the environment and human health and at the same time effective measures for controlling many pests [5-7].

Three bioinsecticides suitable for control of aphids have been registered in Bulgaria: Naturalis, Pyrethrum FS and NeemAzal T/S [8].

Naturalis is a microbial insecticide based on living spores of a naturally occurring proprietary strain (ATCC 74040) of the entomopathogenic fungus *Beauveria bassiana*. The formulated product is a concentrated suspension of

at least 2.3 x 10^7 spores/ml. It is a suspension of conidiospores in vegetal oil, which improves spore germination and UV protection, enhancing the efficacy of the antagonist in the field. *B. bassiana* can affect a wide range of arthropod pests, such as whiteflies, thrips, mites, aphids etc, infesting numerous crops (vegetables, cucurbits, solanaceous fruits, strawberry, flowers and ornamentals, grapevine, citrus, pome, stone fruits, etc.). Recent studies have shown that the antagonistic fungus can effectively control also nut-weevils, wireworms (Agriotes spp.), and Tephritid flies, such as the Mediterranean fruit fly, *Ceratitis capitata*, the cherry fruit fly, *Rhagoletis cerasi*, and the olive fly, *Bactrocera oleae* [9]. The registered concentration is between 0.1% - 0.2% according to the crop [9]. Pyrethrum FS is a botanical insecticide which is extracted from a species of daisy flower (*Tanacetum cinerariaefolium*). It has shown high efficacy and is used against a wide range of pest insects as: aphids, thrips, leafhoppers, fruit flies, flea beetles and many others. It is also one of the few insecticides registered for use in Certified Organic Production of crops in the USA, Europe, Australia and New Zealand. Pyrethrum FS is a fast-acting contact insecticide. Sesame oil is included as a synergist to increase effectiveness. The active ingredients are rapidly broken down by sunlight and are only effective for a short time. In Bulgaria Pyrethrum FS is registered for control of aphids on vegetables in a concentration of 0.05% [9].

NeemAzal T/S is another botanical pesticide with action against small insects and spider mites. azadirachtin is the main active substance extracted from the seeds and leaves of the neem tree (*Azadirachta indica*). The effects of azadirachtin on insects include feeding and oviposition deterrence, growth inhibition, fecundity and fitness reductions [10-12]. Laboratory and field trials with formulated neem seed oil and neem seed extract demonstrated that these materials are effective aphicides [13]. In our country, this active substance is used as the registered botanical insecticide NeemAzal T/S to control spider mites primarily on vegetables in greenhouses in a concentration of 0.3% [8].

Experiments with these products already have been conducted in Bulgaria to control aphids on roses, plum, cherry and apple [14-16].

The present study aimed to establish the efficacy of these three bioinsecticides against the hop aphid *Phorodon humuli* Schrank under laboratory conditions.

2. MATERIALS AND METHODS

The experiments were carried out in the laboratory of Department of Entomology at the Agricultural University of Plovdiv, at a temperature of 24^{0}C and 75% relative air humidity. The efficacy of three bioinsecticides against the hop aphid *P. humuli* was tested. The concentrations of bioinsecticides were established according to their registration for other pests Table 1.

Table-1. Bioinsecticides for control of *Phorodon humuli* under laboratory conditions.

Active substance	Trade name	Concentration
Beauveria bassiana, strain ATCC 74040, 2.3 x 10^7 spores/ml	Naturalis	0.1% and 0.2%
natural extract with contact containing 32% pyrethrum extract (25% pyrethrin) + 32% sesame oil + 36% adjuvants - soft potassium soaps - 0.05% and 0.1%	Pyrethrum FS EC	0.05% and 0.1%
1% Azadirachtin A + 0.5% Azadirachtin B, C, D, + 2.5% Plant Extract from *Azadirachta indica*	NeemAzal T/S	0.3% and 0.5%

http:// nivabg.com.

Natural colonies with minimum 50 nymphs and wingless adults of the hop aphid were collected in the field from infested shoots of apricot (*Prunus armeniaca*) feeding on the leaves and transported to the laboratory. The

branches with aphids were dipped in small bottles with water to keep them fresh for a long time. The treatment was carried out by spraying directly on the aphids colonies with tested concentrations of bioinsecticides and the control was treated with water. Each variant was implemented with three replicates. The number of surviving individuals was recorded on the 1-st, 3-rd, 5-th and 7-th days after the treatment. The efficacy was estimated according to Henderson and Tilton [17].

3. RESULTS AND DISCUSSION

The best results from the tested products showed microbial insecticide Naturalis (*Beauveria bassiana*). The action of the preparation is expected to be slower and on 24 hours after the treatment the results are extremely low - only 26.6% efficacy at both concentrations, due to the need for the development of the entomopathogenic fungi in the host body - treated aphids. In the higher concentration (0.2%) the efficacy quickly increased after the 3-rd day and reached 91.5% on the 7-th day after the treatment. This result is very good for bioinsecticide controlling the aphid density, and the product can be used even under very strong attack by *P. humuli*. The preparation showed very good action in its low concentration (0.1%) where efficacy was 79.8% on the 7-th day after the treatment Figure 2.

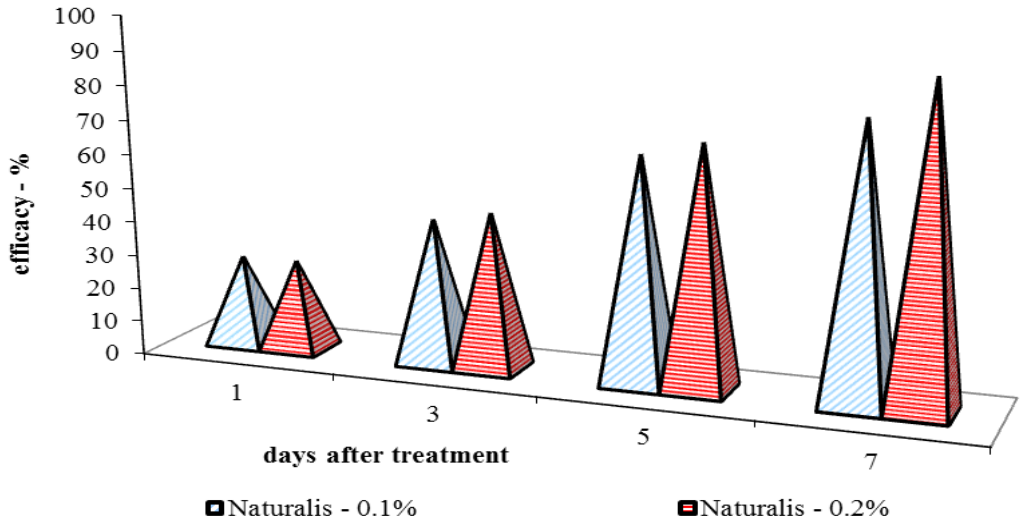

Figure-2. Efficacy of bioinsecticide naturalis (*Beauveria bassiana*) against the hop aphid *P. humuli*.

Similar results obtained [15] in their study of *Hyalopterus pruni*. They found that Naturalis has an excellent effect against *H. pruni* and at concentrations of 0.1% and 0.2% the efficacy reached over 90% and 95%, respectively on the 3-rd day and 98.6% and 100%, respectively on the 7-th day after the treatment. These results indicate that *H. pruni* is more susceptible to *Beauveria bassiana* based product than the hop aphid *P. humuli*.

Insecticides based on plant extracts showed not very good efficacy against *P. humuli*. The Pyrethrum insecticide, based on natural pyrethrins showed better action than azadirachtin based product NeemAzal T/S. Efficacy of Pyrethrum FS EC, applied at 0.1% reached 55.1% on 3-rd day, and 86.9% on the 7-th day after the treatment Figure 3. The result of this insecticide was insufficient in its low concentration (0.05%) - only 28.9% efficacy on the 3-rd day and 75.8% on the 7-th day after the treatment. Despite the weaker result, it can be concluded that natural pyrethrin-based products, applied at an appropriate concentration, are also capable to suppress the attack of hop aphid.

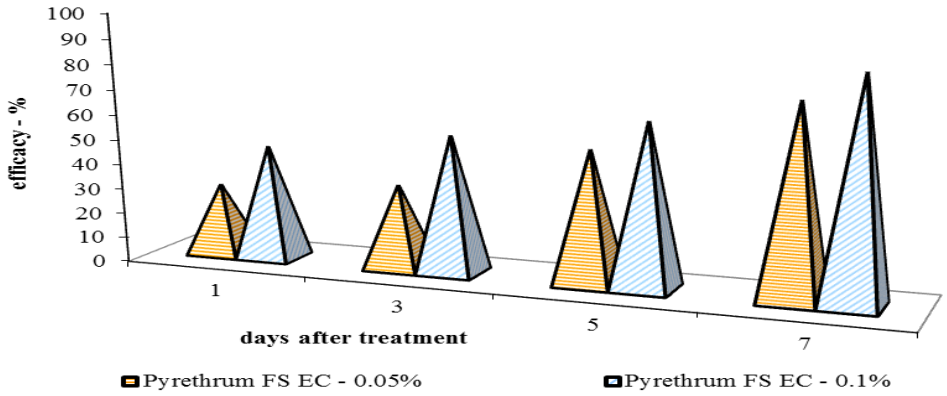

Figure-3. Efficacy of bioinsecticide Pyrethrum FS EC (pyrethrin) against the hop aphid *P. humuli.*

The lowest efficacy against *P. humuli* showed the product with the active substance azadirachtin – NeemAzal Figure 4. The action of this product was delayed and the efficacy was low. At the higher concentration 0.5%, the efficacy was 67.6% on the 7-th day after the treatment and at 0.3% the effect was very low - only 61.6% on the 7-th day after the treatment.

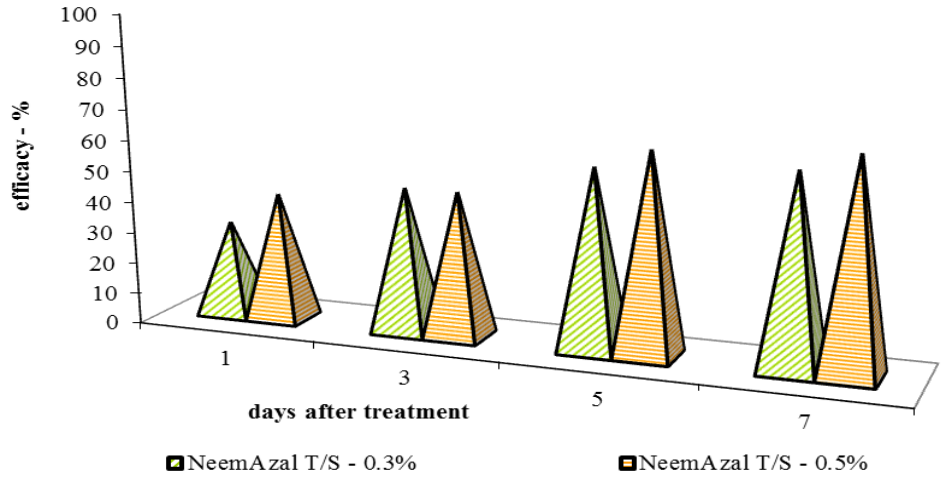

Figure-4. Efficacy of bioinsecticide NeemAzal T/S (azadirachtin) against the hop aphid *P. humuli.*

The similar results for these three products [14] report for control of the rose aphid *Macrosiphum rosae* and control of *Hyalopterus pruni* [15].

4. CONCLUSIONS

The best results from the tested products showed microbial insecticide Naturalis (*Beauveria bassiana*) against *P. humuli.* At a concentration of 0.2%, the efficacy reached 91.5% on the 7-th day after the treatment and in its low concentration of 0.1% efficacy was 79.8% on the 7-th day after the treatment.

The botanical insecticide Pyrethrum FS EC showed not a very good result. The efficacy seven days after the treatment reached 86.9% at a concentration of 0.1% and 75.8% at a concentration of 0.05%.

The weakest action showed the product NeemAzal T/S. The efficacy seven days after the treatment reached only 67.6% and 61.6% at a concentration of 0.5% and 0.3%, respectively.

These results indicate that microbial product Naturalis (*Beauveria bassiana*) and natural pyrethrin-based product Pyrethrum FS EC, applied at an appropriate concentration could successfully controlling the hop aphid *P. humuli.*

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