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# Influence of botanical insecticides on predatory insects under laboratory conditions

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## Abstract

Botanical insecticides play a crutial role in organic agriculture by suppressing pest populations and reducing crop damage. However, their impact on beneficial insects remains insufficiently studied. This study aims to assess the toxicity of three botanical insecticides on the most common predatory insect species in plum orchards. The experiment was conducted in 2024 at the Entomology laboratory of the Fruit Growing Institute - Plovdiv. The active ingredients – orange oil, pyrethrum and *Urtica spp*. – were tested against *Adalia bipunctata* (Coccinellidae), *Macrolophus pygmaeus* (Miridae), *Orius majusculus* (Anthocoridae) and *Chrysoperla carnea* (Chrysopidae). The predatory bug *Orius majusculus* was the most susceptible to all tested botanical products, followed by *Macrolophus pygmaeus*. Adults of the two-spotted ladybeetle (*Adalia bipunctata)* showed the highest resistant to all tested products, followed by *Crysoperla carnea* larvae. By the seventh day after treatment, all tested products exhibited 100% toxicity.

***Keywords:*** botanical insecticides, orange oil, *Urtica* spp., pyrethrum, predators, side effect

## INTRODUCTION

Pesticides are toxic chemical substances that are used in agriculture for disease and pest control. These chemicals have a negative impact on human health and environment (Mahmood et al., 2016). Insecticides are designed to eliminate pests but they are highly toxic to beneficial insects and other non-target organisms (Aktar et al., 2009). In recent years, modern agriculture uses more selective and less toxic products, such as botanical insecticides. They degrade more quickly than synthetic pesticides and have a very short residual activity. Additionally, most are not phytotoxic to plants (Guleria & Tiku, 2009).

In practice, the most popular insecticides of plant origin are Pyrethrum (*Tanacetum cinerariifolium*) and Neem (*Azadirachta indica*) (Isman, 2020). They affect insects, by repelling, feeding deterrents, toxicity, growth retardants, chemical sterilization, and attraction (Hikal et al., 2017). They are harmless for mammals and have no residual effect in the environment (Uchegbu et al., 2011).

The effect of different plant extracts on various pests has been described by many authors. Plant oils from *Ocimum sanctum* and *Annona reticulata* successfully inhibit the oviposition of *Callosobruchus chinensis* and *Callosobruchus maculatus* (Coleoptera: Chrysomelidae) (Prasannath, 2016). Extracts from *Daphne mucronata*, *Tagetes minuta*, *Calotropis procera*, *Eucalyptus sideroxylon*, and *Cinnamomum camphora* successfully reduced aphid populations (Khan et al., 2017). In Pakistan, neem (*Azadirachta indica*) and garlic (*Allium sativum*) extracts were used to control piercing-sucking insects, such as thrips, whiteflies and cicadas (Iqbal et al., 2015). Pavela (2016) provided details about commercially insecticides based on essential oils. Rosemary (*Salvia rosmarinus*), cinnamon leaves (*Cinnamomum verum*) and lemongrass (*Cymbopogon citratus*) are used as repellents for mosquitoes. Peppermint (*Mentha piperita*) is also used against mosquitoes, moths, wasps, and other flying insect pests.

The effect of plant oils and extracts on beneficial insects has not been well studied. Predators and parasitoids are an important part of the ecosystem, as they provide pollination and natural regulation of pests (Getanjaly et al., 2015; Kunbhar et al., 2018). Kunbhar et al. (2018) reported Neem (*Azadirachta indica*), tobacco (*Nicotina tabbacium*) and *Citrullus collocynthus* as less toxic against *Coccinella septempunctata*, *Brumoides suturalis* and *Menochilus sexmaculatus* (Coccinellidae). Nikolova (2016) observed that the biological insecticides NeemAzal and Pyrethrum were nontoxic to *Coccinella septempunctata*. Dutta et al. (2016) also considered Azadirachtin as a safe product for ladybeetles and pollinators. Lami et al. (2024) found that orange essential oil exhibited direct exposure toxicity to ladybeetle larvae, while thyme (*Thymus vulgaris*) essential oil resulted in higher mortality among adult ladybeetles.

The aim of this study is to investigate the toxicity of three botanical insecticides (Limocid, Basictec and Abanto) on the most common predatory insect species in plum orchards.

## MATERIALS AND METHODS

The study was conducted in 2024 at the Entomology laboratory of the Fruit Growing Institute - Plovdiv. A constant temperature of 25±2°C, RH 60-70% and a photoperiod of 16L:8D were maintained at the laboratory. The toxicity of three botanical insecticides (orange oil, liquid extract of *Urtica spp*. and pyrethrins) was assessed on *Adalia bipunctata* (adults), *Macrolophus pygmaeus* (adults), *Orius majusculus* (adults) and *Chrysoperla carnea* (larvae). The predatory insects were provided by the company Bioplanet Balkans, Greece.

***Experimental design***

Testing the toxicity of insecticides was according to the method of The Insecticide Resistance Action Committee (IRAC, 2009). One-year-old shoots taken from plum trees (*Prunus domestica* L.) with the presence of small colonies of aphids (*Hyalopterus pruni* Geoffroy) and mites were dipped for 5 seconds in the solution of the respective botanical insecticide at the selected dose, after which were dried on a grid and placed in a plastic container. In each container, 10 larvae/adults were released using a fine brush. The plastic containers were tightly sealed with lids and stored at 25±2ºC, RH 60-70% and 16:8 h light-dark cycle (Fig. 1). All variants were set in five replications, including the control. The control variant was treated with water. Larval and adult mortality was recorded at 24 hours and at the 3rd, 5th, and 7th day after treatment.

**Figure. 1** Laboratory experiment for assessment of toxicity of botanical insecticides on beneficial insects

The mortality (Eff., %) was calculated by Henderson-Tilton formula:

$$Mortality, \% = 1 - \left(\frac{n\ in\ C\ before\ treatment \times n\ in\ T\ after\ treatment}{n\ in\ C\ after\ treatment \times n\ in\ T\ before\ treatment}\right) \times 100$$

Where : n = Insect population, T = treated, C = control

***Botanical insecticides***

The tested botanical insecticides were orange oil, liquid extract of *Urtica* spp., and Pyrethrum, applied at concentrations based on their registered use for different aphid species. Orange oil (Limocid) is included in the list of biocontrol plant protection products. It is a natural fungicide, insecticide and acaricide. It is recommended for piercing-sucking insects with soft bodies, such as whiteflies, aphids, thrips.

The liquid extract of *Urtica spp.* (Basictec) contains 75 g/L fresh leaves of two varieties of nettle (*Urtica dioica* and *Urtica urens*). The nettle extract has insecticidal, bactericidal and fungicidal effects. It is an organic product recommended for aphids, mites and others.

Pyrethrum, a natural insecticide derived from Chrysanthemum cinerariaefolium flowers (Abanto), acts as a contact insecticide effective against all chewing and sucking pests. It is suitable for both organic and conventional farming, as it degrades rapidly without leaving toxic residues.

## RESULTS AND DISCUSSION

The tested botanical products showed different toxicity towards *Adalia bipunctata*, *Macrolophus pygmaeus*, *Orius majusculus* and *Chrysoperla carnea*. Pyrethrum (0.1%) was less toxic to *Adalia bipunctata* adults. On the 24$^{th}$ hour after treatment, 14% mortality was recorded, while on the 5$^{th}$ day it increased to 87.8%. Similar results were reported by Lami et al. (2024) for adult ladybeetles. Similar results were observed for *Chrysoperla carnea* larvae, and on the 3$^{rd}$ day after treatment the toxicity reached 62.5%. The highest mortality was recorded for *Orius majusculus*, 70% on the first day and 100% on the 3$^{rd}$ day after treatment.

The predatory bug *Macrolophus pygmaeus* was also susceptible to Pyrethrum and 100% mortality was recorded 72 hours after treatment. On the 7th day, Pyrethrum (0.1%) led to 100% mortality of all beneficial insects (Fig. 2).

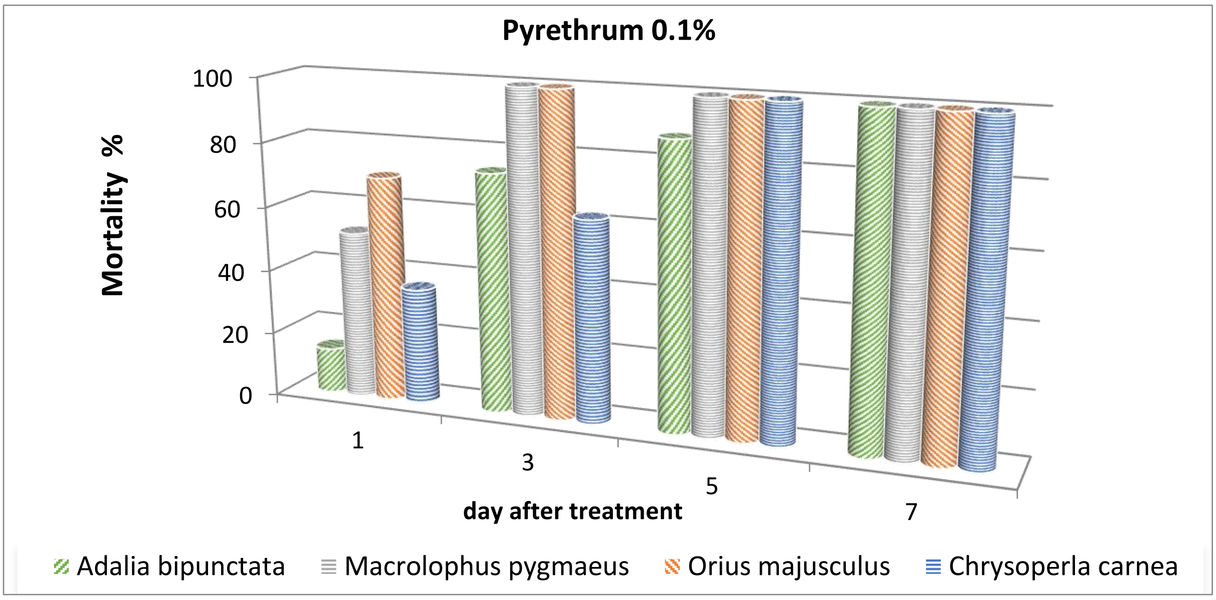


**Figure 2.** Effect of Pyrethrum (0.1%) on predatory insects

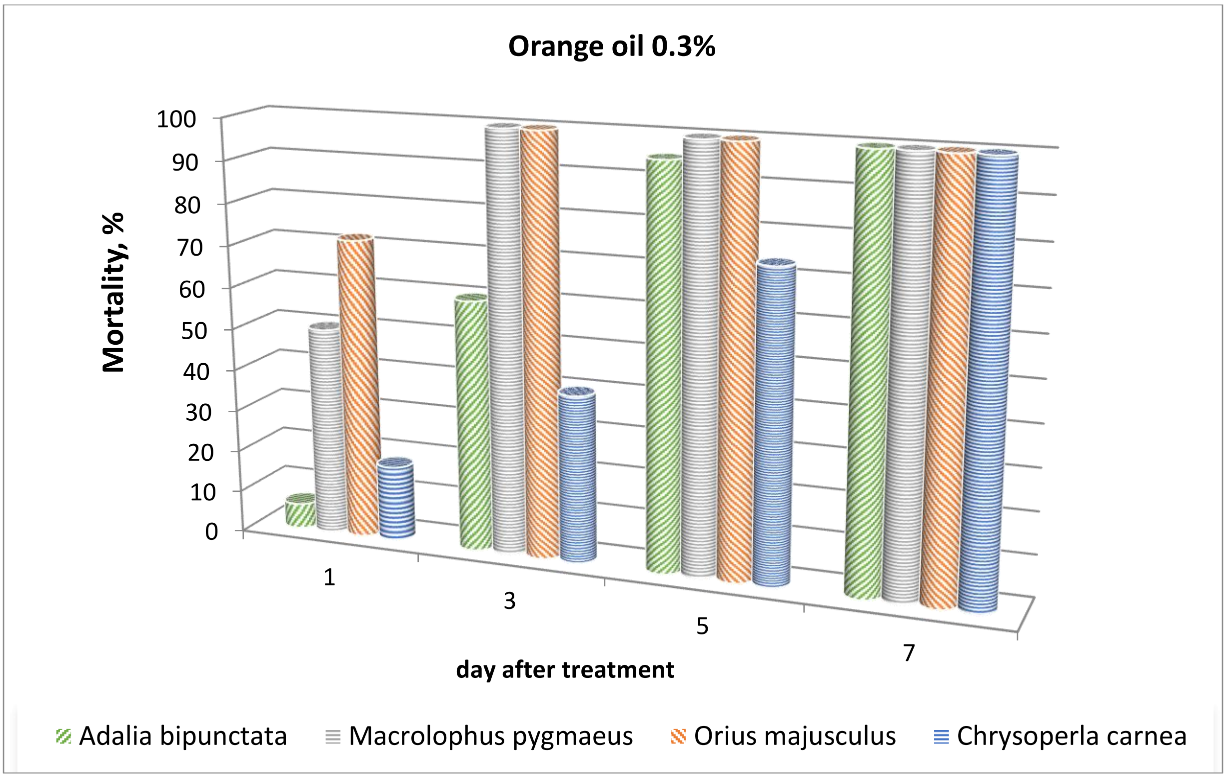


**Figure 3.** Effect of orange oil (0.3%) on predatory insects

Among all tested botanical insecticides, orange oil (0.3%) exhibited the lowest toxicity to *A. bipunctata* adults on the first day after treatment, with only 6% mortality. This result likely reflects the time required for the product's lipophilic properties to penetrate the insect body. Mortality, however, increased rapidly, reaching 60% by the third day and 100% by the seventh day post-treatment. The product also showed promising effects on *Chrysoperla carnea* larvae, with toxicity levels of 18% on the first day and 40% on the third day post-treatment. The predatory bugs *Orius majusculus* and *Macrolophus pygmaeus* were the most susceptible, with 100% mortality observed as early as 72 hours after treatment. The results for *M. pygmaeus* contradict findings from previous studies. According to Mineva et al. (2024), orange oil exhibits only slight toxicity (up to 37%) for this predator. Despite some variability, orange oil (0.3%) demonstrated a 100% effect on all tested predatory insect species by the seventh day post-treatment (Fig. 3).

Similar results were observed for *Urtica* spp. Its toxicity to two-spotted ladybeetle adults was low, with only 10% mortality recorded 24 hours after treatment. However, by the third day, toxicity increased to 66%, slightly exceeding that of orange oil. *A. bipunctata* exhibited the highest mortality on the fifth day, reaching 97.6%, compared to the other two botanical insecticides. *Urtica* spp. also demonstrated strong effects on *C. carnea* larvae, causing 37.5% mortality by the third day after treatment – half the toxicity level of Pyrethrum (0.1%), which reached 62.5%. Both predatory bugs, *O. majusculus* and *M. pygmaeus*, were highly susceptible, with 100% mortality observed by the third day after treatment, consistent with the effects of the other two botanical insecticides. By the seventh day, 100% mortality was recorded for all four predatory insect species (Fig. 4).

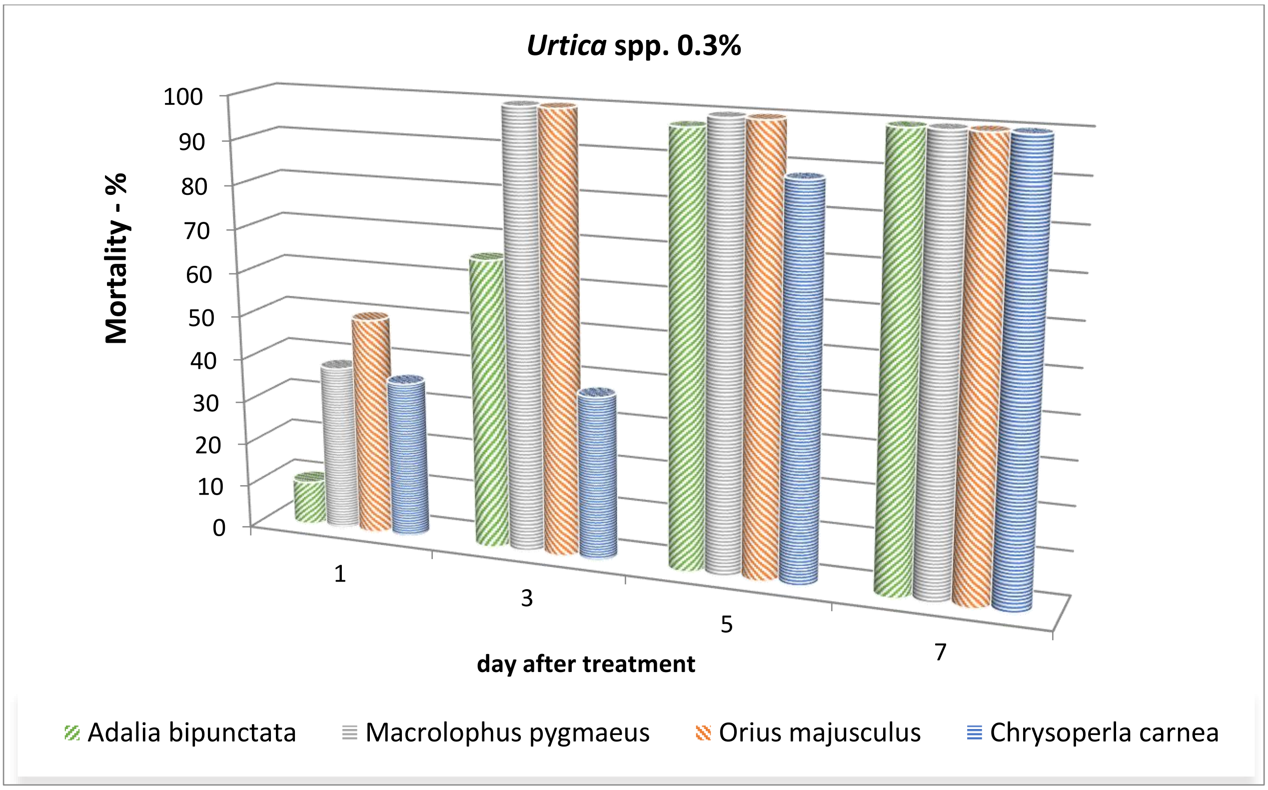


**Figure. 4.** Effect of *Urtica* spp. 0.3% on predatory insects

## CONCLUSIONS

Understanding the effects of botanical insecticides on beneficial insects is crucial for their proper application in practice and for the conservation of species diversity. The results of this experiment indicate that adults of *Adalia bipunctata* (Coccinellidae) exhibited the highest resistance to the initial effects of all tested products. Mortality rates were lowest for all treatments at 24 hours post-application. Orange oil (0.3%) showed the least toxicity to lacewing larvae, with a mortality rate of 18% after 24 hours, while Pyrethrum (0.1%) and *Urtica* spp. (0.3%) had twice the effect. The predatory bugs *Macrolophus pygmaeus* and *Orius majusculus* were the most susceptible to all botanical insecticides, reaching 100% mortality earlier than other tested species – by the third day after treatment. By the seventh day, mortality reached 100% for all species included in the experiment.

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