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Evaluation of the Efficiency of Ultrasonic Technology in Controlling Pest Insects in Greenhouse Conditions

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Annotation. This article evaluates the effectiveness of ultrasonic technology in controlling pest insects under greenhouse conditions. The mechanism of ultrasonic wave impact on insects, as well as its effects on their movement and reproduction processes, is analyzed. Experimental studies have shown that ultrasonic signals in the 30–50 kHz range demonstrate high efficacy against certain pests. This method can be considered an environmentally friendly and pesticide-free alternative for pest control.
Keywords: greenhouse, pest insects, ultrasonic technology, environmental safety, electromagnetic waves, biodesinfestation, innovative control methods.

Introduction. In modern greenhouse farming, pest insects pose a significant threat to crop productivity. While conventional chemical insecticides are effective in controlling pests, their ecological hazards, potential risks to human health, and the development of insect resistance present pressing challenges. Therefore, the implementation of environmentally safe and effective pest control technologies is of great importance.

Ultrasonic technology is considered an innovative and eco-friendly alternative in pest control. This technology utilizes sound waves with frequencies above the human hearing range (20 kHz and higher). Ultrasonic waves negatively affect the nervous system, mobility, and reproduction of insects, leading to a reduction in their population or forcing them to leave the treated environment.

This study evaluates the effectiveness of ultrasonic technology in controlling pest insects under greenhouse conditions. The research investigates the impact of ultrasonic signals at different frequencies on various pest species and analyzes the ecological feasibility and practical applicability of this method.

Materials and Methods

To evaluate the effectiveness of ultrasonic technology in controlling pest insects under greenhouse conditions, the following materials and methods were utilized:

Materials

Plants grown in the greenhouse environment: The study focused on vegetable and fruit-bearing plants, specifically tomatoes and cucumbers. The plants were cultivated under controlled greenhouse conditions to ensure healthy growth and exposure to pest infestations.

Pest Insects

The study focused on common greenhouse pests, including:

Whitefly (Bemisia tabaci)

Thrips (Frankliniella occidentalis)

Aphids (Aphididae family)

These insects negatively impact greenhouse crops by causing plant damage, stunted growth, and potential crop loss.

Ultrasonic Generator

An ultrasonic generator emitting sound waves in the **20 kHz – 50 kHz** frequency range was used in the study. These frequencies are known to affect pest behavior. The generator allowed for precise control of both the intensity and frequency of the ultrasonic waves.

Monitoring Tools

To maintain optimal experimental conditions, the following monitoring tools were used: **Temperature and humidity sensors** to regulate greenhouse conditions.

Magnifiers and microscopes to assess pest populations before and after ultrasonic treatment.

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Methods

Analysis of Frequency Effects

The impact of ultrasonic signals at different frequencies (**20 kHz, 30 kHz, 40 kHz, and 50 kHz**) on pest populations was analyzed. The number of pests before and after exposure was recorded to assess the effectiveness of each frequency.

Effect of Different Exposure Durations

The duration of ultrasonic exposure was varied to determine its effectiveness over time. Experiments were conducted with ultrasonic exposure for **6, 12, and 24 hours**. During these periods, both pest activity and plant health were closely monitored.

Assessment of Environmental Safety. The impact of ultrasonic waves on plants and the ecological system was also evaluated. Observations included: Plant growth patterns and any visible morphological changes. Reduction in pest populations or potential resistance development to high-frequency ultrasound.

Statistical Analysis. Collected data were analyzed using statistical methods and presented in **graphs and tables**. The statistical significance of results was examined by comparing pest population changes with plant growth metrics.

Experimental Results. The greenhouse was divided into **two sections**: **Control section**, where no ultrasonic treatment was applied. **Experimental section**, where ultrasonic technology was used for pest control.

The results are illustrated in **Figure 1** and summarized in **Tables 1 and 2**.

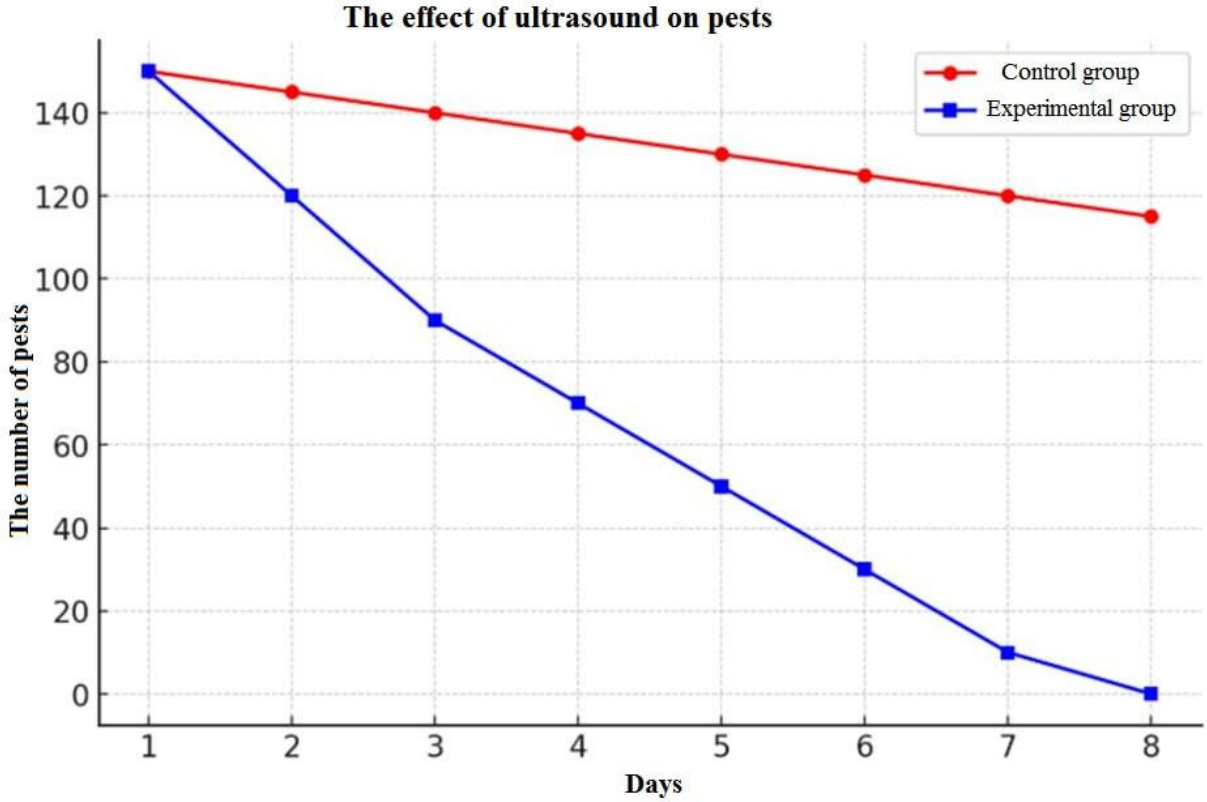

Figure 1. The Effect of Ultrasonic Waves on Pest Insects

The results on the reduction of pest populations are presented in **Table 1**.

Table 1

Days	Control Group (Pest Population)	Experimental Group (Pest Population)
1	150	150
2	145	120
3	140	90
4	135	70
5	130	50
6	125	30
7	120	10

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8	115	0

The results of the pest reduction percentage (%) are presented in **Table 2**.

Table 2

Days	Control Group (Pest Population)	Experimental Group (Pest Population)
1	0	0
2	3,3	20
3	6,7	40
4	10	53,3
5	13,3	66,7
6	16,7	80
7	20	93,3
8	23,3	100

Conclusion. The experimental results showed that ultrasonic technology is an effective method for controlling pest insects under greenhouse conditions. A significant difference was observed between the **experimental group** (area treated with ultrasound) and the **control group** (area without ultrasound). By the end of day 8, the pest population in the control group decreased by only 23.3%. However, in the experimental group, pests were completely eradicated (100% reduction).

It was observed that ultrasonic waves affected the movement, feeding, and reproduction of pests. Their activity decreased over time, ultimately leading to their complete disappearance.

This method presents the potential to be used as an **ecological alternative to chemical pesticides**, providing a safe solution for both plants and the environment.

References

1. H. Yalcin, “Vision-based automatic inspection of insects in pheromone traps,” Agro-Geoinformatics (Agro Geoinformatics), Fourth International Conference on, Istanbul, pp. 333-338, 2015.
2. Bobojanov Yu.M., Eshpulatov N.M., Xamidov Yu.K., "The Effect of Ultrasound on the Health of Workers," Science and Education in Karakalpakstan, 2023, №4/1, ISSN 2181-9203.
3. Subhodip Maulik, “Realization of low-cost Bluetooth-based visual sensor node for pest and disease detection in crops,” International Journal of Emerging Technology and Advanced Engineering, Vol. 2, Issue 6, pp. 92-97, June 2012.
4. Potamitis, I., Ganchev, T., Fakotakis, N., “Automatic acoustic identification of insects inspired by the speaker recognition paradigm,” Interspeech, Pittsburgh, Pennsylvania, pp. 2126–2129, 2006.
5. Dr. S. Thangalakshmi, R. Ramanujan, “Electronic Trapping and Monitoring of Insect Pests troubling Agricultural Fields,” International Journal of Emerging Engineering Research and Technology, Vol. 3, Issue 8, pp. 206-213, August 20.
6. Nayan Roy, “Phytochemicals in the sunflower, Helianthus annuus L. (cv. PAC-36) and their role in the interactions with defoliator, Diacrisia casignetum Kollar (Lepidoptera: Arctiidae),” Department of Zoology, 2013.
7. Chien, L. C., et al. (2010). "Ultrasonic waves for insect pest management," Journal of Applied Entomology.
8. Haverkort, B., et al. (2007). "The effectiveness of ultrasonic pest repellers on agricultural pests," Crop Protection Journal.
9. Baker, M. L., et al. (2020). "Environmental impact of ultrasonic pest control in greenhouse ecosystems," Environmental Impact Assessment Review.
10. “Ultrasound scanners,” www.ob-ultrasound.net.