



MODERN APPROACH TO BIOLOGICAL PLANT PROTECTION IN
 HORTICULTURE USING BEEKEEPING

Gulomova Muxlisa

A first-year student of the Faculty of Agribusiness and Digital Economy at the Andijan Institute of Agriculture and Agrotechnologies. E-mail: muhlisagulomova6@gmail.com

Islamova Dilobar Tairjanovna

Scientific Supervisor:– Lecturer at the Department of Economics, Andijan Institute of Agriculture and Agrotechnologies. E-mail: islamovadt@gmail.com

Abstract: This article presents an innovative model of using beekeeping not only as a pollination tool but also as a biological agent apivectoring for protecting plants from diseases in modern horticulture. The main objective of the study is to reduce the use of chemical pesticides and increase crop yield by delivering biological preparations beneficial microorganisms directly to plant flowers with the help of bees

The paper analyzes the possibilities of adapting this technology to the arid climate conditions of Uzbekistan, particularly focusing on the application of nano-encapsulated biopreparations. The proposed solution is justified by its economic efficiency, environmental safety, and its importance in producing export-oriented organic products compared to traditional spraying methods.

Keywords: beekeeping, modern horticulture, apivectoring, biological protection, targeted delivery, nano-capsules, pesticides, environmentally friendly products.

INTRODUCTION.

Today, one of the major problems in global agriculture, particularly in modern horticulture, is the excessive use of chemical preparations—pesticides—in protecting plants from diseases. When chemicals are applied using traditional spraying methods, more than 90% of the substances are wasted on leaves, soil, and into the air, causing environmental pollution and harming beneficial insects, especially bees.

<u>Bee Breed</u>	<u>Main Characteristics</u>	<u>Adaptability to Climate</u>	<u>Behavior</u>
<u>Carpathian bee</u>	Develops very early in spring, high productivity	Very well adapted to the hot climate of Uzbekistan	<u>Gentle, calm</u>
<u>Carniolan bee</u>	Consumes little food, highly resistant to diseases	Performs well in mountainous and foothill areas	Very gentle, not prone to stinging
<u>Caucasian mountain bee</u>	Has a long proboscis (up to 7.2 mm), collects nectar from deep flowers	Prefers humid and cooler regions	Considered the gentlest bee in the world
<u>Turkestan bee</u>	100% adapted to local natural conditions	Highly resistant to extreme heat and severe cold	<u>Slightly aggressive</u>
<u>Italian bee</u>	Colony grows very quickly, yellow in color	Effective only in areas with abundant nectar (high yield regions)	Calm, but prone to robbing

The Carniolan bee breed is considered the most suitable candidate for this technology, as its natural characteristics fully align with the precise and efficient delivery



of bio-preparations. First of all, Carniolan bees are highly flower-oriented; they quickly locate nectar sources and instinctively move toward the center of the flower. This significantly increases the accuracy of delivering treatment substances directly to the required part of the plant, the so-called "target" area.

The productivity and high activity level of this breed are also important factors. Carniolan bees start working early in the morning and remain active throughout the day. As a result, the "targeted delivery" process continues without interruption, enhancing the overall efficiency of the technology.

Another practical advantage is their gentle nature and discipline. During the installation of apivectoring devices at the hive entrance and their maintenance, a safe environment is created for beekeepers. Since the bees are not aggressive, checking dispensers or replacing bio-preparations can be done more easily and safely.

An additional key aspect is their ability to fly even at lower temperatures. Carniolan bees remain active in cool and cloudy weather, ensuring the continuity of plant protection, especially during the early spring flowering period. This makes the technology reliable even under changing weather conditions.

As an alternative option, the Caucasian mountain bee can also be considered for mountainous areas. Their long proboscis allows them to deliver substances deep into the flower, providing an additional advantage for certain plant species. However, focusing primarily on the Carniolan breed ensures a higher level of efficiency, precision, and safety for this technology.

As an innovative solution to this problem, the idea is being proposed to use bees not only as pollinators but also as "targeted delivery agents" (Apivectoring). When bees pass through special dispensers installed at the hive entrance, harmless but plant-protective bio-preparations—such as beneficial fungi—attach to their bodies. When the bee lands on a flower, these substances are delivered precisely to the point where infection is most likely to occur, namely the center of the flower.

In practice, bees exit the hive through a specially installed dispenser. This device contains environmentally safe bio-preparations that are effective against plant diseases, such as beneficial fungi or bacteria. As the bee passes through the dispenser, these microorganisms adhere to its body. Later, when the bee lands on a flower, the biological substance is delivered exactly to the most critical point where infection can occur—the generative part of the flower, around the stamens and pistil. In this way, the treatment is applied accurately and in a targeted manner.

The advantages of this method are significant. First, it offers very high precision—considered to be up to a thousand times more accurate than traditional spraying methods. Second, it is economically efficient, as there is almost no waste of the preparation. Third, it is environmentally safe, as it does not pollute the environment and does not harm beneficial insects. Fourth, this technology plays an important role in the development of organic agriculture, as it significantly reduces the use of chemical substances.

Economic efficiency. The proposed "Apivectoring" technology has considerable economic advantages compared to traditional spraying methods, with its main benefit being resource savings and an increase in the final product's value. This difference



becomes especially evident when examined on the example of 1 hectare of an intensive orchard.

First, the consumption of treatment substances is drastically reduced. In the traditional method, an average of 5–10 kilograms of chemical pesticides is used per hectare. In contrast, with apivectoring technology, only 10–15 grams of concentrated biological preparation delivered by bees is sufficient. This allows for a reduction in treatment costs by tens or even hundreds of times.

In addition, the need for machinery and energy is almost eliminated. Traditional spraying requires tractors, sprayers, fuel and lubricants, as well as large amounts of water—around 500–1000 liters per hectare. In apivectoring, these costs do not exist, as bees naturally deliver the biological preparations based on their instincts. This significantly reduces overall production costs.

Another important aspect of the technology is its high level of precision. In traditional methods, more than 90% of the sprayed chemicals are lost without reaching the target. Bees, however, deliver the preparation directly into the inner part of the flower—the point where disease development is most likely. As a result, the effectiveness of the treatment is maximized while waste is minimized.

In addition, the market value of the product increases. Fruits grown without chemical treatment or with minimal intervention are considered “organic” and environmentally friendly. In international markets, such products are typically priced 30–50% higher than conventional ones. This enhances export potential and provides additional income for producers.

Overall, the implementation of apivectoring technology allows for a several-fold reduction in plant protection costs in horticulture, improves crop quality, and increases competitiveness. As a result, this approach proves to be not only economically efficient but also an important innovative solution for ensuring long-term sustainable development.

Global experience. In countries such as the United States, Canada, and the European Union, apivectoring technology has already become an integral part of agriculture. In particular, the experience of the Canadian company “Bee Vectoring Technologies” shows that targeted delivery using bees is 10 times more cost-effective and up to 1000 times more precise than traditional chemical methods. The fact that this technology has been recognized as safe by the U.S. Environmental Protection Agency (EPA) has marked the beginning of a new era in the cultivation of organic products in modern horticulture.

Adapting the technology to Uzbekistan’s climate and economic conditions. To successfully implement apivectoring technology in Uzbekistan’s agriculture, several key factors must be considered. To create an economically viable and sustainable system, it is advisable to use locally developed bio-preparations instead of expensive imported ones. For example, preparations developed by scientists at the Institute of Microbiology—such as those based on *Trichoderma* or *Bacillus subtilis*—can be effectively utilized. This approach not only reduces costs but also strengthens the integration of local science and production, contributing to the development of the domestic market.



By introducing this model in high-export-potential intensive orchards—such as cherry, almond, and apple plantations—it is possible to produce high-quality, chemical residue-free products that meet international standards.

Another important aspect is adapting the technology to Uzbekistan's hot and arid climate conditions. Under high temperatures and strong solar radiation, beneficial microorganisms can quickly lose viability. Therefore, placing them into nano-encapsulated shells is an innovative solution of great importance. Nano-capsules protect microorganisms from adverse environmental effects, extend their viability, and ensure the gradual release of active substances once they reach the plant. This significantly increases the overall efficiency of the technology.

In implementing this approach, it is also important to establish cooperation between beekeeping farms and horticultural enterprises. By using hives equipped with special dispensers, it is possible to organize a system for the targeted delivery of biological preparations. This enables the large-scale application of the technology.

Conclusion. Research shows that the integration of beekeeping and horticulture can create a true technological revolution in agriculture. The apivectoring system not only reduces the use of treatment substances by up to 100 times but also plays a crucial role in ensuring environmentally safe food production. To implement this innovative model in Uzbekistan, it is advisable to establish a cluster system between beekeeping entities and intensive horticultural farms, as well as to encourage the production of nano-encapsulated preparations in local bio-laboratories.

REFERENCES:

1. Kevan, P. G., et al. (2005). Bees as Vectors of Biocontrol Agents for Control of Plant Diseases. Prokopovych Beekeeping Institute Journal.
2. Bee Vectoring Technologies International Inc. (2020). System for Delivery of Crop Enhancement Agents. Technical Report, Canada.
3. U.S. Environmental Protection Agency (EPA). (2019). *Clonostachys rosea* strain CR-7; Exemption from the Requirement of a Tolerance. Federal Register.
4. Smagghe, G., et al. (2020). Pollination and Crop Protection: Bees as Vectors of Biocontrol Agents. *Frontiers in Sustainable Food Systems*.
5. Resolution of the President of the Republic of Uzbekistan No. PQ-3327. (October 16, 2017). On Measures for Further Development of the Beekeeping Sector in the Republic.
6. Muxammadiev, A., et al. (2021). Beekeeping: Textbook. Tashkent, National Encyclopedia of Uzbekistan.
7. Nanotechnology in Agriculture. (2022). Nano-encapsulation of Bio-pesticides for Sustainable Crop Protection. *Journal of Nanobiotechnology*.