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Bee Vectoring Technology (BVT): A Natural Revolution in Crop Protection

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ABSTRACT

Bee vectoring technology (BVT) is one of the emerging systems that provides better health to crops by controlling pests and diseases. It protects crops through targeted application of organic products like pesticides and herbicides. In this process, mostly bumblebees or *Apis mellifera* are used as a vector to deliver microbial agents to the crop. A special instrument called a dispenser is installed at the entrance of bee hives through which all the bees pass and get the component of organic products all over their body. By using the natural process of pollination, all the bees carry these organic components to the target flowers, and that's how we can achieve better seed production, crop protection, and crop yield. This technology is effective in crops that benefit from pollination, which includes berries, almonds, and tomatoes, but it is not suitable for self-pollinating crops. It also has some drawbacks, such as spreading disease in crops by carrying pathogens and competition among vector species.

Keywords: Bee vectoring technology, Crop protection, pollination, *Apis mellifera,* Organic products

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Introduction

BVT is commercializing a system that uses the natural pollination process used by bees to provide safe, organic product treatment for crops, help them control pests and diseases, and achieve higher yields for farmers [1]. Bee vectoring is a technique that uses these pollinating bees' innate tendency to visit flowers in search of nectar or pollen to manage disease and pests [2]. BVT has developed a natural precision agriculture system that replaces chemical pesticides and wasteful crop protection spray applications by providing organic pesticide substitutes for commercially grown crops. A certain pollinator, such as bees, referred to as the vector, must deliver a microbial bio-control agent product to the crop under protection in a way that is safe for humans, the vector, and the environment. It means BVT's Precision Vectoring is completely safe for bees and can remove trace amounts of natural pesticides [3]. At the entrance to beehives, bee vectoring dispensers with microbial agents are placed to ensure that bees entering the hive are coated with the microbial agents. While they are foraging, the microbial agents are transferred to the crops by bees [3].

The use of bumblebees as a bee vectoring has been commercialized in several countries. It is a system that combines bumblebee pollination with biological crop protection, which is available in Asia, Europe, Africa, and the America for control of gray mold in berries [3]. In order to transport bio-control chemicals that boost seed production and protect plants from diseases, this article explores a strategy that uses pollinators like honeybees to provide pollination and associated agricultural services. It reduces the cost of labour and time while reducing exposure to non-target organisms [5]. Because of its beneficial effects, BVT is one of those innovations that is strengthening its roots in the present day. Worldwide, pollinators and bio-control agents are widely used. In 2015, more than 30 million hectares were treated with microbial and invertebrate agents [6].

Science behind BVT

BVT is one of the emerging natural crop protection systems. It controls pests and diseases by taking advantage of the pollinating bees' basic urge to visit flowers in search of nectar or pollen. For this purpose, a unique bee vectoring device is placed at the entrance of beehives to make sure that bees entering the hive are coated with the microbial agents and that is known as a dispenser. That's how the microbial agents are delivered to the crops by bees while they are feeding [3]. In this procedure, bees act as a vector but in some regions, bumblebees are being sold out for use as bee vectors. For instance, Biobest Flying Doctor, a system for controlling gray mold in berries that combines biological crop protection and bumblebee pollination, is accessible in Asia, Europe, Africa, and the America [3]. A BVT pesticide offers better crop protection and improves soil health, micro-biome health, and the environment, compared to traditional chemical pesticides. BVT is composed of two essential components: microorganisms, such as fungi, bacteria, or other natural agents, and a system of equipping bees with special dispensers to distribute microorganisms during pollination to crops [7].

Advancement in BVT

A promising method for improving crop pollination and precision bio-control at the same time is api-vectoring by utilizing the mutually beneficial effects of pollination and anti-pathogenic qualities. Although the main options for entomovectoring are honeybees and bumblebees, investigating native species can provide long-term advantages, especially in areas without research or raising facilities [4]. Several writers have documented the creation of several dispenser systems that enable the loading of vectors with a biocontrol agent throughout the last 20 years. One-way and two-way dispensers are the two types of dispensers used in entomovectoring investigations. Vectors pass through the powder both when they depart and return to the hive in one-way dispensers because the entrance and exit chambers are either the same or partially split [8].

On the other hand, two-way dispensers make sure that only the vectors leaving the nest get into contact with the powder because their entrance and exit chambers are fully isolated. For *A. mellifera*, eight different types of dispensers as well as a few modified versions have been developed thus far. Six bumble bee dispensers were created concurrently, including three for *Bombus terrestris*, two for *Bombus impatiens*, and one for *Osmina cornuta*, the lone orchard pollinator [8]. This technique, which integrates crop production and protection, has the potential to completely transform modern agriculture. A significant step toward environmentally friendly farming methods that guarantee a healthy environment is the adoption of entomovectoring [8]. Purchasing local plants promotes pollinator biodiversity, increases system efficiency, and lessens transportation-related issues. Api-vectoring has enormous potential for ecosystem health and sustainable agriculture [5].

Benefits of BVT

Bee vectoring makes it possible for pesticides to be transported and dispersed specifically to the flowering sections of plants. Additionally, the use of antagonistic bacteria and fungi as microbial agents in bee vectoring has added the benefit of lowering problems associated with synthetic chemical fungicides and antibiotics. The effectiveness of bee vectoring against a wide range of illnesses and pests, including fungus, whiteflies, greenhouse whiteflies, weevils, beetles, moths, and thrips, has been shown in numerous studies [2]. This technology is used in crops such as strawberries, raspberries, pears, apples, sunflowers, oilseed rape, and tomatoes [9]. BVT's Precision Vectoring is completely safe for bees and can remove trace amounts of natural pesticides [4]. In 1992, honeybees were used to transfer the fungus *Gliocladium roseum*, a biocontrol agent to protect strawberry plants from *Botrytis cinerea*. In order to protect strawberry plants from *Botrytis cinerea*, Peng carried out the first entomovectoring trial using *Apis mellifera* and the microbial BCA *Gloocladium roseum*. Due to the ensuing decreased foraging activity, this technique was able to inhibit *Botrytis cinerea* on the flowers in the greenhouse and in the open field, with the exception of inclement weather [4].

Bee vectoring is mostly used for pest control and pollination, which increases crop output and is predicted to have major economic benefits. The commercialization of bumblebees alone generated €55 million for the pollination industry in 2004 [4]. Bee vectoring was estimated to generate an extra $2,987 per hectare from increased yield through pollination, $1,405 in savings from less pesticide use, and an additional $872 in savings from fewer pest-related losses in a Colombian study on strawberry gray mold. Three times the expense of putting bee vectoring into practice, the total estimated yearly profit per acre could be $3,710. Fruit crops that are self-incompatible could benefit from the effective cross-pollination that bee vectoring technology offers [2].

Limitation and drawbacks of BVT

Despite numerous benefits of BVT, it also has some drawbacks such as spreading disease in crop by carrying pathogens and competition among vector species, etc. Native bee species may be impacted by the growing commercialization and the anthropogenic movement of pollinators. It may affect the local bee fauna by acting as pathogen reservoirs and introducing harmful viruses into native wild bee population. There have been reports of high parasite loads in a number of commercial bee populations [4]. Invasive bumblebee species frequently engage in foraging activities that overlap with native bumblebee species. Therefore, by competitive exclusion, the invading species may displace the native species. The local bee fauna may suffer from competition for nesting locations and floral supplies. Lastly, native bee species may suffer from interspecific mating between invading and native bumblebee species.

To preserve its native species, Norway has prohibited the importation of commercial bumblebees and exclusively utilizes native or domestically cultivated species. The pathogenic protozoan *Apicystis bombi* was introduced into the native species *Bombus dahlbomii* by *Bombus terrestris*, according to research conducted in 2013 by Arbetman and Maharramov. *Apicystis bombi* samples from both before and after the introduction of *Bombus terrestris* served as the basis for their results. They discovered that the disease had co-evolved with *Bombus terrestris* and was a contributing factor to the decline in *Bombus dahlbomii* populations. The overlap in visited plant species in comparison to the two invasive Bombus species is another factor contributing to the decline of *Bombus dahlbomii* [4].

Conclusion

In conclusion, BVT is one of the advanced and innovative methods for improving crop health through disease and pest management. It protects crops through the targeted application of organic products such as insecticides and herbicides. *Apis mellifera* or bumblebees are primarily used as a vector to transfer microbial agents to the crop. At the entrance to bee hives, a unique device known as a dispenser is placed, through which all bees pass and distribute the organic product component throughout their bodies. One-way and two-way dispensers are the two types of dispensers used in this technique. We can improve seed production, crop protection, and crop output by employing the natural pollination process, in which all bees transport these organic components to the target flowers. This technology can also help in better cross-pollination in crops, which ultimately increases crop yield. It also has some drawbacks despite having so many benefits and potential for future advancement. It may cause disease spreading in crops by carrying pathogens and competition among vector species.

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