

# Pollination by bees in industrial crop production

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**Abstract.** In recent decades, beekeepers have faced challenges from the massive use of pesticides, climate change and the emergence of new diseases. Taking into account the fact that, as a result of the mass use of chemical plant protection products, the number of wild pollinating insects has significantly decreased, bees are the most effective performers of the pollinating function. In the last twenty years, Russian farmers have come to understand the role of bees in the industrial agrobiocenosis. It is economically advantageous to orient bees to efficient pollination, which requires a high concentration of colonies in a small area. The importance of bees in sunflower production goes beyond mere pollination. Studies have shown that plants visited by bees have a higher seed set, resulting in higher yields. In addition, the pollination process improves seed uniformity and quality. Since industrial crop production implies the placement of one monoculture on large areas, then, naturally, a large number of bees should be delivered to the sunflower array at once by the beginning of flowering. Only mobile beekeeping can cope with this task. Mobile beekeeping is a dynamic and adaptable approach to beekeeping, offering beekeepers increased flexibility, improved honey production.

## 1 Introduction

As diligent and industrious pollinators, bees have played an important role in ecosystems for centuries. By pollinating, they ensure the reproduction and diversity of flowering plants. Over the past two centuries, their role in pollination has become even more significant due to the expansion of commercial agriculture and the growing food needs of the world population. Bees, especially honey bees, are responsible for pollinating a huge variety of crops, including fruits, vegetables, oilseeds, fodder, and others. Their contribution to world food production cannot be overestimated. The industrial revolution of the nineteenth century brought about significant changes in agricultural practices that had both positive and negative effects on bees. The increased mechanization of agriculture has opened up new opportunities for crop production, resulting in vast areas occupied by monocultures. This expansion often meant the destruction of natural habitats and the reduction of floral diversity, which affected the availability of food for the bees [1, 2].

During the last two centuries, beekeeping techniques have evolved significantly. Beekeepers began managing hives to maximize honey production, which contributed to the development of modern beekeeping techniques. The detachable frame hive revolutionized

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beekeeping and provided better hive management and honey extraction methods. This innovation greatly expanded beekeeping as a profession and contributed to the expansion of the production of honey and other bee products [3].

In recent decades, beekeepers have faced challenges from the massive use of pesticides, climate change and the emergence of new diseases. The heavy use of pesticides, especially neonicotinoids, has raised concerns about their impact on bee health and colony survival. Climate change has also disrupted the timing of flowering and changed ecological relationships, affecting the ability of bees to synchronize their life cycles with flower resources [4, 6].

Given the role of bees in ecosystems and food production, efforts to conserve and protect bees are gaining momentum around the world. Governments, organizations and individuals are taking action to create bee-friendly habitats, reduce pesticide use and raise awareness about pollinator conservation. Initiatives such as planting pollinator-friendly gardens, promoting organic farming practices and creating protected areas for bees contribute to their long-term survival and biodiversity conservation [7].

Protecting bees means keeping our ecosystems in balance and ensuring a constant supply of varied food.

## **2 Materials and methods of research**

The aim of the research was to analyze the symbiotic relationship of bees with agricultural crops and the influence of bees on the yield of the most important entomophilous crop.

In the course of the study, general methods of scientific knowledge were used, including monographic, abstract-logical and statistical-economic methods.

## **3 Research results and discussion**

It is well known that the fundamental process in plant reproduction is pollination, that is, the transfer of pollen from male reproductive organs to female counterparts in flowers. Bees are one of the main pollinators, visiting flowers in search of nectar and inadvertently transferring pollen from one flower to another. This cross-pollination facilitates fertilization and ensures the production of viable seeds and fruits. Bee pollination is based on a wonderful symbiotic relationship between plants and bees. When bees forage for nectar, they inadvertently collect pollen grains on their furry bodies. As they move from flower to flower, the pollen is transferred between plants, promoting fertilization and seed production. This complex pollination process is controlled by millions of bees.

It should be noted that almost 75% of the world's leading food crops depend to some extent on insect pollinators. Taking into account the fact that, as a result of the massive use of chemical plant protection products, the number of wild pollinating insects has significantly decreased, bees are the most effective performers of the pollinating function [8].

The interdependence between bees and crop yields goes beyond simple food production. The contribution of bees to the economy is significant. The global value of pollination services provided by bees is estimated at hundreds of billions of dollars annually. Bee pollination improves the quality and marketability of fruits, vegetables, nuts and other cash crops, increasing agricultural profits and supporting rural livelihoods.

In the last twenty years, Russian farmers have come to understand the role of bees in the industrial agrobiocenosis. It is economically advantageous to orient bees to efficient pollination, which requires a high concentration of colonies in a small area [9, 11].

In the Southern Federal District, under one of the main honey-bearing entomophilous crops - sunflower - 2370.2 thousand hectares are occupied, that is, almost a quarter of the Russian land (Table 1). It should be noted that according to the data of the Ministry of Agriculture of the Kuban alone, the under-pollination of sunflower due to the lack of bees in the region brings a loss of about 5.0 billion rubles.

**Table 1.** Sown areas of sunflower, thousand hectares

	2005	2006	2007	2008
Russian Federation	5567.8	7153.5	7005.0	10121.5
Southern Federal District	2519.5	2423.0	1618.6	2370.2
Republic of Adygea	45.2	69.8	60.4	62.4
Republic of Kalmykia	35.0	12.7	3.5	10.1
Krasnodar Region	583.5	494.1	436.2	511.0
Astrakhan region	0.1	-	-	-
Volgograd region	658.5	827.8	584.1	759.8
Rostov Region	1194.2	1019.5	534.3	953.8

In order to stimulate the development of beekeeping in the region, in 2004 the regional law “On beekeeping” was adopted, which allows the possibility of paying for the services of honey bees. Realizing the effectiveness of bee pollination, many farms invite beekeepers to pollinate entomophilous crops. Field owners already pay for sunflower pollination (900-1000 rubles for a family of bees from 8-9 streets). Bees are efficient pollinators due to their unique behavior and physical adaptations. When bees are looking for nectar and pollen, they inadvertently brush against the anthers, picking up pollen grains on their bodies. When visiting another sunflower plant, they carry some of the pollen on the stigma, promoting fertilization. This process triggers the development of seeds, which eventually leads to sunflower seeds.

Several factors contribute to the efficiency of bees in pollinating sunflowers. The large size and strong structure of the sunflower heads provide the bees with ample space to plant, allowing them to access the nectar and pollen rich buds. In addition, the abundance of pollen with its high nutritional value attracts insects. The bright yellow color of the sunflower caps also serves as a visual cue for the bees, guiding them to the floral resources they are looking for.

The importance of bees in sunflower production goes beyond mere pollination. Studies have shown that plants visited by bees tend to have a higher seed set, resulting in higher yields. In addition, the pollination process improves the uniformity and quality of sunflower seeds, resulting in seeds with higher oil content and better nutritional properties. The symbiotic relationship between sunflower and bees ultimately contributes to sustainable and profitable farming.

The partnership between bees and sunflower plants goes far beyond pollination. Plants provide bees with a rich and nutritious source of food. Nectar collected from sunflower flowers stimulates the energy-consuming activity of bees, while pollen serves as a source of protein for their offspring. In addition, sunflowers provide bees with a platform for sunbathing and thermoregulation as they collect heat from the sun-warmed petals.

The union of bees and sunflowers is of great ecological importance. By facilitating the pollination process, bees contribute to the reproduction and genetic diversity of sunflower populations. Sunflowers, in turn, provide habitat and livelihood for the bees, increasing their population and ensuring their long-term survival. This harmonious relationship illustrates the interconnectedness of species in the natural world and highlights the important role of pollinators in maintaining the balance of an ecosystem. Thus, the partnership between bees and sunflowers directly affects our food systems and agricultural productivity.

Since industrial crop production implies the placement of one monoculture on large areas, then, naturally, a large number of bees should be delivered to the sunflower array at once by the beginning of flowering. Only mobile beekeeping can cope with this task.

The challenges for the development of this form of beekeeping are, along with the shortage of bee colonies, the lack of serial production of mobile pavilions, the complex mechanism for their registration with the traffic police; shortcomings in the organization of training for beekeeping.

The yield increase due to pollination amounted to 15%. With an average sunflower yield in the Krasnodar Territory of 26.2 q/ha and a purchase price of 20 rubles/kg, this amounts to 7860 rubles in value terms. / ha. Taking into account the fact that one bee colony of 8 streets per 1 ha is required for effective pollination on sunflower crops, the revenue, minus the payment for pollination services in the amount of 1000 rubles per colony, will be 6860 rubles.

## 4 Conclusion

Mobile beekeeping is a dynamic and adaptable approach to beekeeping, offering beekeepers increased flexibility, improved honey production, enhanced pollination services and reduced pesticide exposure. With the growing interest in sustainable farming, mobile forms of beekeeping have become a practical and flexible solution for beekeepers.

By adopting mobile forms of beekeeping, we can protect and promote these vital pollinators while conserving ecosystems and ensuring the continued availability of agricultural resources. The role of bees as pollinators is essential to global food security, agricultural sustainability and economic prosperity.

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