



bee care

Honey Bee Health

Understanding the issues, providing solutions





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Honey bee



Sculpture of a dome-shaped hive,
Denmark (1823)

All about bees

THERE CAN BE NO DOUBT THAT HONEY BEES SHOULD BE PROTECTED SO THAT THEY CAN CONTINUE TO PROVIDE HONEY AND CARRY OUT THE POLLINATION SERVICES THAT ARE SO CRITICAL TO FOOD PRODUCTION.

Imagine a flower garden with bees buzzing around busily collecting the nectar they will turn into delicious honey. Honey bees may appear a small part of this appealing picture, yet they have an important role to play for people and nature. Honey bees mainly feed on nectar and pollen for their energy and protein source. In their search for food, they also pollinate the flowers they visit. The focus is often on honey or beehive products, such as wax or royal jelly. Yet the greatest service honey bees provide is pollinating agricultural crops. Pollination increases the yield and quality of many crops and its value to agriculture is at least €150 billion worldwide. Bees and other pollinators also make a valuable contribution to maintaining biodiversity: many flowers set their fruits only after a pollinator has visited them, and these fruits provide essential food for wildlife. Pollinators include honey bees, wild bees, bumblebees, solitary bees, butterflies, wasps, beetles, birds and bats.

The Western (or European) honey bee (*Apis mellifera*) is well established in many parts of the world and relied on to perform most of the commercial pollination. At the heart of the honey bee colony is the queen, which can lay up to 2,000 eggs a day and lives for 2 - 4 years. Colony duties are carried out by up to 60,000 female worker bees, which live for an average of 2 - 4 weeks during the summer. Several hundred male drones live during the summer months and serve only for reproduction purposes. The worldwide honey bee population increased by around 45% between 1961 and 2007. While managed colonies decreased in some parts of the world (particularly in parts of Europe and the USA), increases occurred in Asia, Africa, South America and Australia. A reduction or increase in the number of colonies in some areas may simply be linked to the number of beekeepers, however there are many other influencing factors too.

✳ **Before sugar cane or sugar beets were cultivated, an important source of sweetener (apart from fruit or maple syrup) was honey, collected from colonies of wild honey bees. As civilization evolved, these bees were offered nesting opportunities to facilitate honey collection and the beehive was born. Pictorial images of hives first appeared on Egyptian monuments around 2,400 BC.**



Honey bee health

THE NUMBER OF BEES IN A HIVE NATURALLY VARIES THROUGHOUT THE YEAR. THEIR NUMBERS MAY DROP FROM A PEAK OF UP TO 60,000 BEES IN MIDSUMMER, TO ONLY 8,000 AFTER A LONG WINTER.

Honey bee pests and pathogens

Since the 1950s, a parasitic mite known as *Varroa destructor* has spread to almost every Western honey bee hive, except in Australia. The mite was introduced from the Asian honey bee (*Apis cerana*). The latter co-evolved with the mite and has specific behavioral characteristics, such as hygienic grooming, that help minimize the effects of the mite. Other bee races, such as Africanized honey bees, also exhibit behavior patterns that reduce build-up of *Varroa*: they swarm more frequently, leaving behind high parasite infestations in the brood. The Western bee no longer has such defense mechanisms, due to selective breeding to remove these traits, and is thus more vulnerable to this parasite.

The parasite impacts honey bee health when it sucks on the hemolymph of adults and larvae, spreading viruses among the bee population. In all, about 20 bee viruses are known to exist, including Acute and Chronic Bee Paralysis and Deformed Wing Virus. Australia, presently *Varroa*-free, has some of the healthiest Western honey bees on the planet. The financial implications for *Varroa* infestation are significant. By one estimate, the economic loss that would occur if the mite should enter Australia would be €11- 26 million a year over the next 30 years.

Various other bee pathogens and pests exist: *Nosema apis* and *Nosema ceranae*, unicellular fungal parasites, are almost global in distribution; the Small Hive Beetle (*Aethina tumida*) is found in the USA, Africa and Australia; and the Asian Hornet (*Vespa velutina*), a predator, is spreading in Europe. In addition, the European Foulbrood (*Melissococcus plutonius*) and the American Foulbrood (*Paenibacillus larvae*) are bacterial diseases which infect the gut of bee larvae. Both of these are wide-spread diseases and the American Foulbrood, especially, has negative effects for the brood of the colony.

“Colony Collapse Disorder”

Since autumn 2006, US beekeepers have reported mysterious mass disappearances among honey bees. At this time, the symptoms observed cannot be attributed to any particular cause or pathogen. Colonies experiencing a collapse, rapidly lose most of their adult bees, which leave the hives in order to die elsewhere. The few remaining bees show an unusual spectrum of bacterial and viral infections, or even parasite infestation and fungal diseases.

US bee researchers have coined the term Colony Collapse Disorder (CCD) to describe this alleged phenomenon. Only a few colony losses can be described as CCD. The term “colony losses” of bees is used, irrespective of the causes or specific symptoms, whereas CCD is a clearly defined syndrome with particular criteria.



Varroa mite on bee larva

CHALLENGES

The *Varroa* mite currently stands out as the key threat to honey bee health as it proliferates rapidly and transmits pathogenic viruses.

Mite management relies on a limited number of practices and a similarly limited portfolio of chemical treatments to which resistance has already been observed. The small size of the market for such products, their relatively difficult access for beekeepers in some countries (because of the need for veterinary prescriptions) and the new challenges continually being discovered are contributing to the magnitude of the task.

SOLUTIONS

The most efficient way of managing bee health in the short term is by enhancing hive health through good apiculture practices. These include hygienic measures, a sound knowledge of pathogen and bee life cycles, as well as making the best use of currently available mite management solutions.

Harmonization of bee health data-recording within and across country boundaries has been identified as a prerequisite for implementing effective measures and helping to guide research approaches.

Breeding bees to have increased natural *Varroa* resistance is useful as part of an integrated approach. It is, however, a challenging goal and solutions are not likely to be achieved in the short term, nor can they be expected to be long lasting. New mite treatment options are being investigated by various institutions and companies. Bayer has been offering a variety of products for many years. They are approved for *Varroa* control according to national veterinary regulations and the mite's occurrence. In addition, further technological solutions are currently being developed.

HONEY BEE HEALTH CHALLENGES AND LOSSES HAVE BEEN DESCRIBED FOR CENTURIES AND ARE DUE TO A VARIETY AND COMBINATION OF CAUSES. TODAY, BEES FACE MANY CHALLENGES, WHICH INCLUDE WELL KNOWN PESTS SUCH AS THE VARROA MITE, AND NEW PESTS INCLUDING VIRAL INFECTIONS, *TROPILAELOPS* MITES, SMALL HIVE BEETLE, AS WELL AS TO SOME EXTENT, INSUFFICIENT FORAGE HABITAT WHICH PROVIDES NECESSARY FOOD AND A VARIETY OF NUTRIENTS AND UNFAVORABLE WEATHER EVENTS.

Bees need good nutrition

Under temperate climatic conditions, naturally occurring plants and agricultural crops provide a wider variety of flowers in springtime which tails off later in the year. Agricultural crops, which are used by honey bees for foraging, include canola/oilseed rape, fruit and vegetables. Some provide better bee forage and are more nutritious in terms of nectar and pollen (protein content and quality) than others. Wind-pollinated crops, such as cereals (barley and wheat) do not produce nectar which attracts honey bees and other insects. Besides quantitative availability all year round, the quality and diversity of forage is important. Good nutrition throughout the year has been identified to be a key factor for good health of wild bees and honey bees alike.



Bee on oilseed rape



Insect hotel for wild pollinators



Flower strip

CHALLENGES

The need to feed the ever increasing size of the world's population has inevitably required bringing more land into food production, thereby reducing the foraging opportunities for many pollinators.

SOLUTIONS

Everyone can contribute to the increased availability of bee forage, for example, by planting nectar- and pollen-rich plants, shrubs or trees. Measures to promote pollinator conservation initiatives contribute in this respect. The positive effects of flower strips on farm areas are well known. They can be further promoted if farmers are compensated for potential yield reduction when implementing such measures. It is important, however, to realize that good foraging habitat is part of the overall solution to improving bee health and is not the only factor that has a role to play. Bayer promotes sustainable crop management practices, including evaluating measures to enhance on-farm biodiversity and promoting bee health through the creation of foraging and nesting opportunities. Our Bee Care Flowering Program has been established to encourage the creation of sustainable and attractive habitats for bees and other beneficial insects with various partners including municipalities, home and garden retailers and beekeepers.



Honey bees can be affected by the weather

Irregular or severe winter weather cycles, such as early and wet springs or a sudden return to winter weather, can put undue stress on honey bees – either directly (in that they may not be able to maintain the required temperature in the hive) or indirectly (through reduced nectar flow in flowers). Likewise, periods of unusually rainy or severe weather events such as flooding, storms, drought or sudden temperature extremes may negatively influence honey bees just as much as by impacting floral nectar production.



Bee hives

CHALLENGES

Over the past decade, average annual losses (ca. 5 - 15 %) of honey bee colonies have in some cases doubled or been even higher. Although climate change is resulting in more frequent unfavourable weather events in some parts of the world, this is not the primary cause of higher winter losses but rather an additional stressor for bees.

Good beekeeping practices

Management practices vary greatly throughout the world and have to be adapted locally. Differences also depend on the beekeeping purpose: honey production or provision of pollination services.

For example, every year more than a million hives are transported over long distances to help pollinate the almond crop in California. Frequent and long-distance colony transport may be an additional stress factor for bees.

SOLUTIONS

While beekeepers remain dependent on good weather conditions, it has been shown that honey bee pathogens and poor nutrition are the major factors influencing bee health.

Honey bee safety and crop protection products

THERE ARE STRONG TIES BETWEEN AGRICULTURE AND BEEKEEPING. AS SUCH, AGRICULTURAL PRACTICES CAN INFLUENCE BEE HEALTH IN MANY WAYS. THE EFFECTS OF PESTICIDES ON HONEY BEES WERE TESTED AS EARLY AS THE 1920S. EVER SINCE, TESTING REQUIREMENTS HAVE EVOLVED AS SCIENTIFIC KNOWLEDGE INCREASED.

Pesticides: Laboratory and field studies

A reasonable first assumption is that an insecticide might have an effect on an insect such as the honey bee, yet effects vary significantly depending on the nature of the active ingredient and the formulation of the product. It is therefore essential either to demonstrate bee safety or to determine measures to minimize bees' contact with crop protection products.

A step-by-step approach to bee safety evaluation begins with laboratory studies and progresses, as required, to include semi-field and field studies. Depending upon the outcome of these studies, tailored use recommendations for each product are provided on labels.

CHALLENGES

Laboratory research focuses on the response of bees to different pesticide application rates - including deliberate overexposure. Such research is useful for product evaluation but results do not imply that they are transferable to "real world" field exposure conditions. Thus, care must be taken to draw the right conclusions from the findings of laboratory studies.



Laboratory feeding of bees

SOLUTIONS

The evaluation of pesticides from a bee safety perspective makes use of study protocols and guidelines developed by experts. What really matters in this cascading process is the interaction between a bee and a pesticide in real field situations. In some cases, avoiding effects may be as simple as not spraying when the crop is flowering.

Bayer is highly committed to ensuring that its products will be used in a "bee-responsible" manner. This includes thoroughly researching its pesticides, developing focused stewardship techniques, training farmers accordingly and monitoring the products in the field.

Product monitoring

Our commitment to bee safety extends beyond merely selling pesticides and does not stop once a product has been officially approved for use. As new products are commercialized, the evaluation process continues and benefits from monitoring as well as customer experience and feedback gained from the field. Updating regulatory files with new scientific findings of products is equally a continuous process and a legal requirement. It is considered "flexible" to allow integration of lessons learned.



Evaluating honey bee combs

Challenges

Varying worldwide use conditions in the field have to be considered for the implementation of stewardship measures and outreach to farmers and other users of our technologies.

SOLUTIONS

Laboratory and field studies, combined with "real-world" field experience, are essential in the development of technologies that will protect both bees and crops.

Following pesticide label recommendations is naturally beneficial to bees' safety. In addition, cooperation is needed between farmers and beekeepers to optimize spray times and minimize exposure to foraging bees.

As a research-based company, Bayer moves forward by incorporating the lessons learned from product field monitoring into improved technologies. This is a critical part of our broader approach to promoting responsible and sustainable pesticide use.

DIFFERENT INSECTICIDES HAVE VARYING EFFECTS ON BEES. IN CASES WHERE EFFECTS MAY POTENTIALLY BE EXPECTED, SPECIAL CARE MUST BE GIVEN TO USE THEM IN A “BEE-RESPONSIBLE” MANNER. STRICTLY FOLLOWING STEWARDSHIP MEASURES AND LABEL RECOMMENDATIONS IS CRUCIAL IN THIS RESPECT.

The use of neonicotinoid insecticides in agriculture has been seen by many as having revolutionized our ability to control damaging pests in a more environmentally-friendly way. Despite this, others have sought to take a different view of this type of insecticide. What has contributed to the latter view and what is our perspective?

Benefits of neonicotinoid insecticides

Neonicotinoids are an important family of insecticides introduced two decades ago and adopted by farmers around the world because of their effectiveness in controlling harmful and destructive crop pests, some of which are showing resistance to other insecticides already on the market. Bayer's neonicotinoid products are widely used in a variety of applications including as seed-applied insecticides and as sprays. With systemic seed treatments, active ingredients are taken up by the seeds and thus protect them from within against soil-borne pests as well as early season foliar pests during the seeds development into a young plant.

Applying an insecticide to a seed is very eco-efficient: less than 1% of a given area is treated compared to the whole area in a spray application; pests that feed on the plants are especially exposed; and potential airborne drift to beneficial insects (which help to manage pests) and water bodies is reduced. What is more, fossil fuels (and with that greenhouse gas emissions) are saved since treated seed saves at least one tractor operation otherwise required for spraying the young plants. Not all neonicotinoids are the same and some are so bee-friendly that they can be applied on flowering crops without causing harm to honey bees.

Farmers value all the added agronomic and economic benefits associated with healthier plants, increased yield and time spared.



Treated seeds



Some people attributed bee losses with imidacloprid use in France during the late 1990s, despite evidence that treatment-resistant *Varroa* and other bee health issues were the cause. Later, a specific incident with clothianidin occurred in Germany which resulted in the introduction of new quality control measures for seed treatment to prevent reoccurrence.

Although the use of some neonicotinoid products has been restricted in France for over ten years, no significant improvement in honey bee health has been seen as a result of this. Clearly, there are other, more important, factors which are still having a negative impact on honey bee health in France. Today, despite these observations, the debate around the use of neonicotinoid insecticides continues.

Study Results

Many large-scale multifactorial studies were undertaken in the USA, Austria, Belgium, Canada, France and Germany. These have shown that poor bee health is correlated with the presence of *Varroa*, viruses and many other factors, but not with the use of insecticides.

The findings of a long-term German bee monitoring survey initiated in 2004 have confirmed these results. It involves many stakeholders, including over 100 beekeepers with about 1,500 bee colonies. The same results have been found during long-term monitoring studies in France and North America.

Stewardship Measures

With the aim of continuously improving the proper use of our technologies, various stewardship measures have been developed and implemented in close cooperation with many stakeholders.



Sowing machine with exhaust air deflector

Bayer's commitment and contribution to honey bee health and safety

Bayer has an inherent interest in promoting sustainable agriculture and preserving bee health. In managing our own plant breeding business, we rely on honey bee pollination and fully acknowledge the value of honey bee pollination services to agriculture.

- ✱ We are committed to finding solutions to enhance honey bee health and safety by:
 - Bee Health: through the provision of *Varroa* management products and exploring potential new treatments;
 - Bee Safety: ensuring the sustainable and responsible use of plant protection products through research and promotion of “bee-friendly” farming practices;
 - Dialogue and Cooperation: sharing knowledge and expertise with stakeholders in the beekeeping and agricultural communities and with scientific and governmental institutions, NGOs, policy makers and regulators.





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