



Science For A Better Life

Honey bee care

Challenges and solutions



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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 are vital to people and nature.

The focus of beekeepers 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 has been estimated at about €153 billion worldwide.

Bees mainly feed on nectar and pollen for their energy and protein source. In their search for food bees also pollinate wild flowers. In this way, they make an immeasurable contribution to biodiversity: many flowers set their fruits only after a bee visit, and these fruits provide essential food for wildlife. Pollinators include honey bees and thousands of wild bees (such as bumblebees and 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 1,500 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 6 weeks during the summer. Several hundred male drones live during the summer months and serve only for reproduction purposes.

The worldwide bee population almost doubled between 1961 and 2007. While managed colonies decreased in some parts of the world (Europe, North America), 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, yet there are many other influencing factors too.

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



Bumblebee



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

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 PATHOGENS

Since the 1950s, a parasitic mite known as *Varroa destructor* has spread to almost every Western honey bee hive, except Australia. The parasite impacts bee health by feeding on honey bees and 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*.

It is interesting to note that colonies of African or Africanized honey bees in South America and Africa are more resilient to the mite because of their hygienic (grooming) behavior by which they actively remove the mites from their bodies. Australia, presently *Varroa*-free, enjoys some of the healthiest Western honey bees on the planet.

Various other bee pathogens exist: *Nosema apis* and *Nosema ceranae*, unicellular parasites, are global in distribution; the small hive beetle (*Aethina tumida*) is found in the US; and the Asian Hornet (*Vespa velutina*), a predator, is spreading in parts of France, Spain and North America. In addition, the American and European foulbroods are bacterial diseases.

“COLONY COLLAPSE DISORDER”, US

In the US, worker bees have been reported to be disappearing from colonies, leaving behind the queen and her brood. These specific symptoms have been termed “Colony Collapse Disorder” (CCD) and a combination of factors is thought to be involved. Numerous questions still remain unanswered. Similar “disappearing” behavior has been reported in different kinds of social insects, which leave their “homes” when they are very sick so as to protect their fellow insects.



Varroa mite on bee larva and adult bee

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 apiary 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. A product acquired in 2010 will complement our existing portfolio and further technological solutions are being explored.

Invasive alien species (IAS) are plants, animals, pathogens and other organisms that are non-native to an ecosystem. Their introduction and/or spread threaten biodiversity.



A sign raising awareness of IAS, South Africa: Durban Botanic Gardens

HONEY BEES, AGRICULTURE AND INVASIVE ALIEN SPECIES

Alien species that become invasive have been recognized internationally to be a main direct driver of biodiversity loss across the globe. They are also acknowledged to cost the global economy hundreds of billions of euro/dollars each year. In agriculture, the annual environmental losses caused by pests introduced in the US, the UK, Australia, South Africa, India and Brazil have been calculated at over €68 billion.

The *Varroa* mite is just another example with significant financial implications. 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.

The *Varroa* mite is a prime example of how the Western honey bee is suffering from an IAS introduced from its Asian counterpart (*Apis cerana*). The latter co-evolved with the mite and has specific characteristics that help minimize the effects of the mite. Other bee species such as Africanized 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 does not have such defense mechanisms and is thus more vulnerable to this parasite. Other introduced pests may include the *Tropilaelaps clareae* mite, the small hive beetle and the Asian hornet.



Small hive beetle

CHALLENGES

IAS can be a serious threat for agriculture and apiculture alike. While the threat of species migration has always existed, they are spreading faster than ever before thanks to greater global mobility, increased world trade and changing climate patterns.

The sudden and unprecedentedly high impact of an introduced species presents a significant challenge, especially if control measures are unavailable, or fail.

SOLUTIONS

Increasing awareness and understanding of the potential implications of IAS is an overarching issue, critical for food supply and biodiversity conservation.

At an international, regional and national level, systems for animal disease notification are in place. They provide management solutions for introduced species, including honey bee pathogens, in an effort to reduce their spread.

Bayer provides various tools to manage IAS, including plant and animal health products as well as technical approaches. One of our bee health products is used in the management of the small hive beetle in the US and Canada and could potentially be used should the beetle reach European shores.



Bee foraging on goldenrod

Non-native invasive alien plants such as goldenrod (*Solidago* spp.) or Indian balsam (*Impatiens* spp.) introduced to countries in Europe, however, provide nectar and pollen for bees in summer and autumn when natural forage sources become scarce, thereby helping bees to overcome periods of reduced food availability.

Honey bee health challenges and losses have been described for centuries and are due to a variety and combination of causes. Today, bees face new challenges, which include relatively new pests such as the *Varroa* mite, viral infections and other pathogens, to some extent insufficient forage and increasingly unfavorable weather events.



BEES NEED GOOD NUTRITION

Under temperate climatic conditions naturally occurring plants and agricultural crops provide a variety of flowers in springtime and fewer later in the year. Some agricultural crops – canola/oilseed rape, fruit and vegetables – provide better bee forage in terms of nectar and pollen (protein content and quality) than sunflowers. Wind-pollinated crops, such as cereals (barley, maize, rice and wheat) do not produce bee (and other insect) attracting nectar.

Besides quantitative availability all year round, the quality and diversity of forage is important for maintaining the health of wild bees and honey bees alike.



Bee drinking

CHALLENGES

Globally, the increasing world population is “paving” more and more land, which leads to habitat loss and, with that, a loss of bee forage. Likewise, efficient agricultural production requires a greater concentration of crops per farm. This in some areas can contribute to reduced forage diversity for the bees too.

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 improve agroecosystems vary and are referred to as environmental farm plans, stewardship, land-care or pollinator conservation initiatives. 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 realise that good forage alone will not solve bee losses caused by pathogens.

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. This is done in cooperation with many stakeholders.

HONEY BEES ARE SENSITIVE TO THE WEATHER

Irregular 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, prolonged rainy or dry weather may negatively influence honey bees just as much as by impacting floral nectar production.

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 about a million hives are transported over long distances to help pollinate the almond crop in California. Frequent and long-distance colony transport amounts to an additional stress factor for bees.

CHALLENGES

Over the past decade, average annual losses (~ 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.

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. Addressing these would improve overwintering.



Bee hives in winter

HONEY BEE SAFETY

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.



Laboratory: checking larvae



Honey bee field studies

PESTICIDES: LABORATORY AND FIELD RESEARCH

A reasonable first assumption is that an insecticide might have an effect on an insect such as the honey bee, yet effects vary significantly on a case-by-case basis. 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 field and observational 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 over-exposure. 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.

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 during blooming.

Bayer is highly committed to ensuring that its products can be used in a “bee-responsible” manner. This includes thoroughly researching its pesticides, developing focused stewardship techniques and then monitoring the products in the field.



Laboratory feeding of bees

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.

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 crops and bees.

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.

Evaluating honey bee combs



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.



BENEFITS OF SEED-APPLIED 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 crop pests. Bayer’s neonicotinoids Gaucho® (imidacloprid) and Poncho® (clothianidin) are insecticides that are widely used as seed-applied insecticides. They are products taken up by the seeds and thus protect them from within against soil-borne pests as well as early season foliar pests when the seed develops 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; especially pests that feed on the plants are exposed; and potential 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.

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

Neonicotinoids’ use has been controversially debated regarding honey bee safety. What contributed to this and what is our perspective?

Bee losses were first attributed to imidacloprid in France during the late 1990s. They were not related to specific product incidents, but the product market introduction coincided with a time when bee health issues had increased. Later, an accident with clothianidin occurred in Germany which resulted in enhanced mitigation measures to prevent reoccurrence.

Today much more is known about the bee safety of the neonicotinoids. Nevertheless as a result of this situation the debate continues.

Many large-scale multifactorial studies were undertaken in the US, 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 1,000 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.

They involve:

- higher seed quality standards to ensure the treatment sticks to the seed
- enhanced dust-drift-reducing equipment to deflect exhaust air into the soil
- customized training for commercial seed experts at our regional Seed Treatment Application Centers in many countries
- outreach to farmers through so-called “seed bag tags” containing all the necessary information

All these measures have been shared with many countries, some of which have adopted them as legal requirements. Lessons learned have proved very valuable in moving forward and understanding how they can be integrated into technology development.



Sowing machine with exhaust air deflector

Treated seeds

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:

- providing *Varroa* management products and exploring potential new treatments;
- ensuring the sustainable use of pesticides through research and promotion of “bee-responsible” farming practices;
- sharing knowledge and expertise with stakeholders in the beekeeping and agricultural communities and with scientific and governmental institutions, NGOs, policymakers and regulators.

At the heart of our commitment to honey bee health lies our portfolio of *Varroa* mite management products. In 2010, we acquired a new product derived from natural thymol oil, which we are further developing for use in some countries. Additional innovative solutions for bee health are currently underway and reaffirm our commitment.

