PROTECTING BEES FOR GENERATIONS TO COME

Crop protection product research, as well as introducing new products to the market, is subject to strict regulations. The experts at Bayer have to make certain that their products are safe for bees, when used correctly. This is why they are also carrying out laboratory studies on the younger generation of these insects – honey bee larvae. In the future more tests – both in the laboratory and the field – will be conducted to develop methods for bumble bees and wild bees.

Dr Maria Teresa Almanza
Head of the Bee Testing and Risk Assessment Group of Environmental Safety at Bayer

"We are constantly investigating new testing methods to ensure we are protecting bees based on up-to-date scientific approaches."

Farmers benefit greatly from the pollination services provided by honey bees, but at the same time they have to protect their crops against weeds, fungal diseases and harmful insects. Crop protection products, thus, play an essential role in farming. The products should be as selective as possible, to ensure they are safe to the environment, and especially to beneficial organisms, but can still control pests. This situation presents a challenge for plant protection researchers. Crop protection products have to comply with strict regulations before they receive approval: A specific use of every product must be safe for honey bees – and the standards are steadily increasing. "To meet these evolving requirements, we work with international experts on developing new procedures that allow us to optimize the safety testing of crop protection products," says Dr Maria Teresa Almanza, Head of the Bee Testing and Risk Assessment Group of Environmental Safety at Bayer. The entomologist and her team study the bees' sensitivity to crop protection products.

It has long been obligatory in the European Union and in many other parts of the world for crop protection products to be tested on adult honey bees before they can enter the market. But less has been known about how these products affect the bee brood, in particular the larvae and this has subsequently been taken up in the scientific and regulatory communities. "There are cases where testing of adult bees alone would not cover all relevant aspects of the ecotoxicological profile of a substance," says Dr Almanza.

This is why Bayer bee experts have teamed up with international experts since 2006 to investigate laboratory procedures that bring the bee larvae into direct contact with the substances. "This larvae test complements the toolbox of first-tier testing methods which are conducted in the laboratory under standardized conditions, and aims to gain information about the intrinsic toxicity of the tested substances," says the bee laboratory director Dr David Gladbach. To work out exactly how these types of tests should be conducted, several institutions carry out preliminary research. In most cases, these so-called ring tests involve various separate laboratories from industry and research working together, with the key objective to generate robust and reproducible data. The final result may be an official guideline. In 2013, the International Organisation for Economic Co-operation and Development (OECD) published the acute larvae test as "Test guidance document 237"

AT A GLANCE

// Bayer experts test crop protection products on honey bee larvae to optimize the safe use directions for the products in the field.
// Prescribed standardized test procedures ensure that studies are comparable across different laboratories.
// The researchers are also developing new testing methods for wild bees and bumble bees.

Dr David Gladbach
Bee Laboratory Director

"We want to develop reproducible tests to obtain comparable results."

after seven years of development research. In addition to the acute exposure which is addressed in the OECD 237 design, there is also the chronic larvae test for which an OECD Guideline has been discussed recently.

"The acute larvae test is already part of the current requirements for the approval of many crop protection products in Europe and in the USA. The chronic larvae test is set to become compulsory in the USA in the near future," says Dr Almanza. The latter test design will expose the bee larvae to the test substance for several days, comprising all juvenile life stages.

The specifications for developing and carrying out the larvae test are very precise: Researchers study at least 36 larvae from a minimum of three queens in one cycle. They must also have a control group of bee larvae that, for direct comparison, is not treated with the test substance. Even the temperature of the test surroundings is precisely stipulated to be 35 degrees Celsius. There is a strong reason for such strict rules: "The test results will only be comparable within and particularly between laboratories, if they comply with the standardized framework," explains Dr Gladbach.

At the start of the test, young bee larvae are transferred from their cells in the combs of the beehive to the experimental test units. “There must be no more than 30 hours between the hatch of the oldest and youngest to minimize the age variation of larvae that go into the test,” says the scientist. The food intake of the bee offspring is also precisely specified and adjusted to the various stages of development. The food is a mixture of royal jelly, yeast extract, glucose and fructose. In the laboratory, scientists make sure the developing brood is fed exactly according to plan, and they keep a close eye on the young insects: “Four days old larvae are given a small amount of the test substance in their food. The dosage also depends on how the adult bees previously tolerated the chemical,” explains Dr Gladbach. In the days that follow, for the acute test, the larvae continue to receive their food without the test substance, and the researchers count how many larvae completed their development with the spiked food.

The bee larvae are kept in an incubator at 35 degrees Celsius (below). At least 36 bee larvae are studied in each trial (above).

The honey bee is the most researched of all bee species. Nevertheless, findings relating to their sensitivity of certain substances cannot always easily be transferred to other bee species such as bumble bees and solitary bees. “We are currently investigating new testing methods to make sure that we are also protecting these important pollinators based on scientifically sound approaches,” says Dr Almanza. “Bumble bees, in particular, are often used as commercial pollinators in greenhouses. It is very important for farmers to know how to avoid harming them.” These species display different nesting and feeding behavior, and even vary in terms of their biology. For example, solitary bees, almost by definition, do not build colonies in the way that honey bees and bumble bees do; instead, one female feeds her entire brood alone.

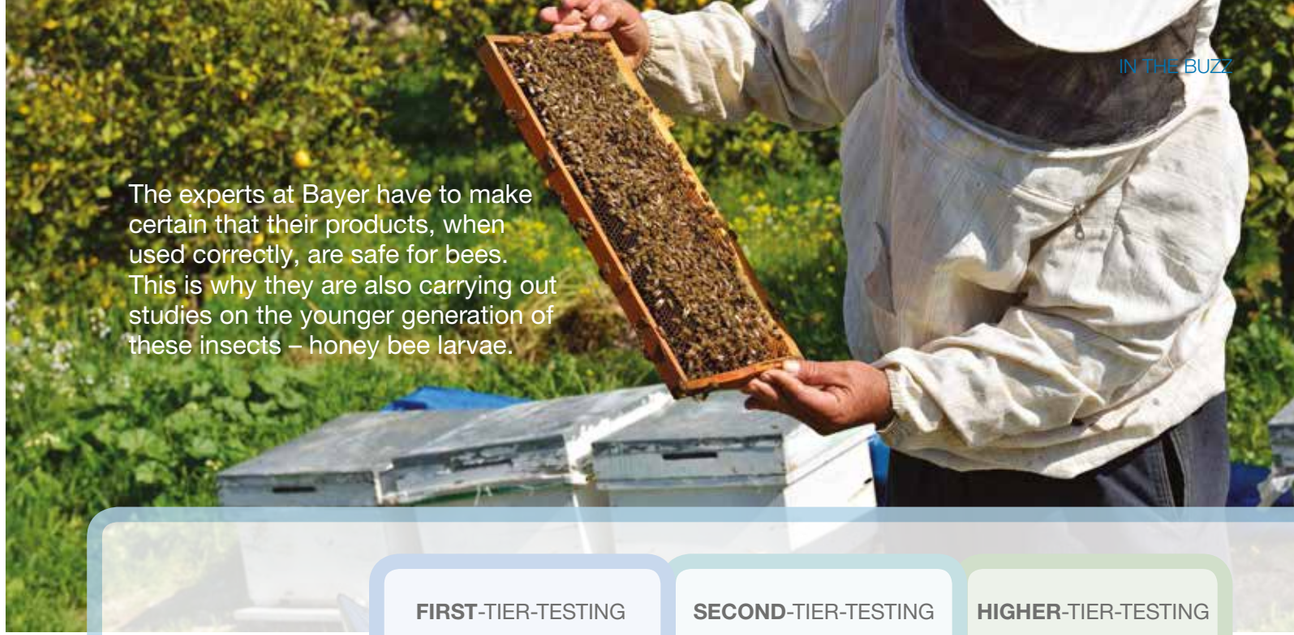
“We have to take into account the different biologies of bumble bees and wild bees and develop suitable testing methods to ensure the best possible testing conditions for these insects,” says Dr Gladbach.

To achieve these goals, Bayer experts work together both in the lab and in the field, collaborating closely with external experts as part of working groups within the OECD and the International Commission for Plant-Pollinator Relationships (ICPPR). One challenge for new tests is to create suitable conditions. “The laboratory and field environments should be correctly set up to be able to identify substance-related effects in the test,” explains Dr Gladbach. The researchers have already made a start on studying wild bees. They are carrying out initial trials with bumble bees and representative species of solitary bees in laboratory and semi-field tests. The aim is to establish new validated testing methodologies before products can be tested on a standard basis, which takes time, as illustrated by the example of the honey bee larvae test. Bee species are different, so ensuring the safety of crop protection products for bee species in all stages is an important requirement for sustainable agriculture.

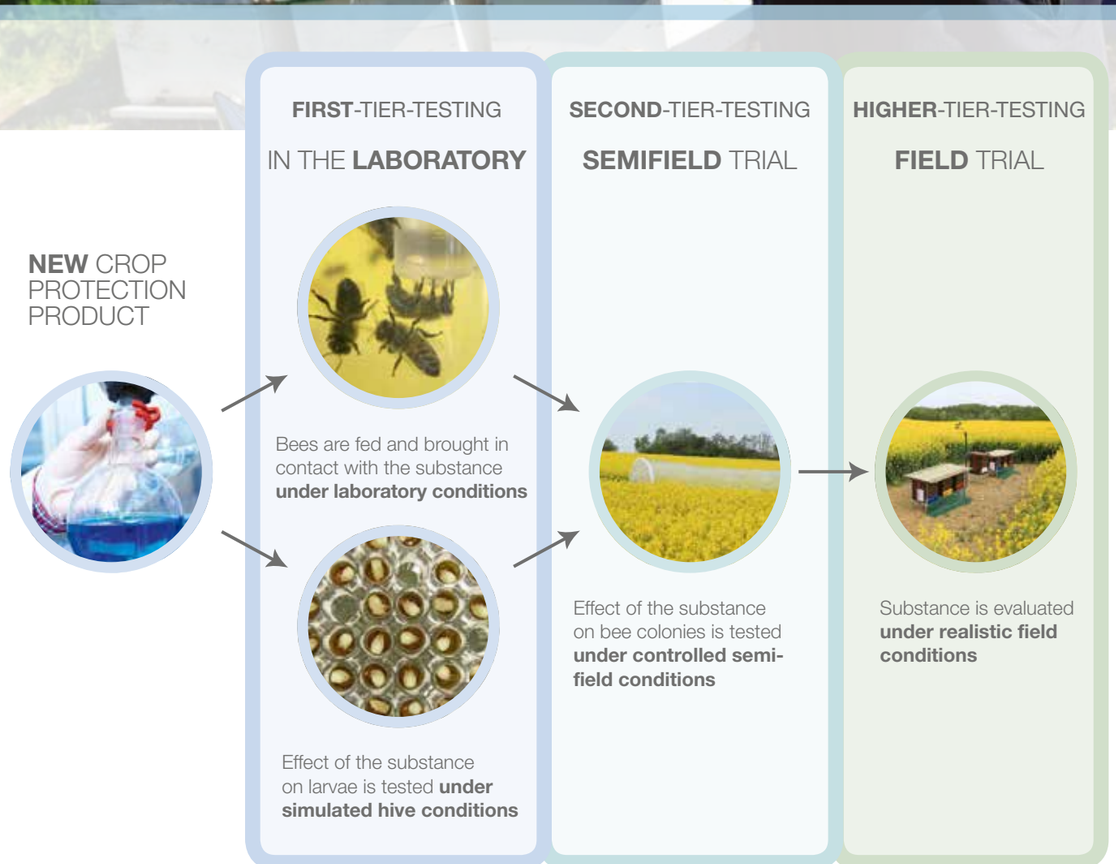
CONCLUSION

Certain crop protection products may be of low intrinsic toxicity for adult bees but potentially more harmful for their brood.

Researchers at Bayer are, therefore, testing the products on bee larvae. Bayer is also supporting the development of new study types that look at bumble bees and solitary bees.



The experts at Bayer have to make certain that their products, when used correctly, are safe for bees. This is why they are also carrying out studies on the younger generation of these insects – honey bee larvae.



Tests to keep pollinators healthy
For a crop protection product to receive approval, it must first pass a series of tests. This simplification of the test pathway for new plant protection products (above) shows the different stages of testing involved. The substance can only be declared “not harmful to bees” after having undergone thorough laboratory and frequently also field tests. Products that are found to be intrinsically toxic to bees can only be used under strict conditions – for example, they may not be used on flowering plants.