Molecular biology reveals resistance in weeds

DNA analysis to find mutations

Weed resistance to herbicides has increased dramatically in recent years. In the interests of efficient resistance management to prevent resistance spreading even further, Bayer CropScience researchers have started using modern molecular biology methods alongside conventional studies, helping farmers all over the world to guarantee high yields and cut down on herbicide use.

Samples of weed seeds arrive at Dr. Hubert Menne's laboratory in the mail. Every year, the agronomist at Bayer CropScience receives around 2,000 samples from all over the world at his laboratory, and this number is growing all the time. Farmers with a weed problem send these samples so that Menne can grow them under glass and test them for potential herbicide resistance. "If a sample is sent to us, it doesn't necessarily mean that it is resistant," he explains. "Sometimes the herbicides have been used wrongly or at too low a dose, despite the training and instruction the farmers receive." Menne and his team investigate the samples in the traditional way: in the greenhouse. They sow the seeds and treat the plants which grow from them with various herbicides until it becomes clear which ones work and to which ones the weeds have become resistant. However, the greenhouse test is a purely reactive one – the weed seeds can only be tested after the crop has been harvested, so the farmer only gets the team's recommendations for resistance management in time for the following season.

However, since several years ago the Bayer CropScience researchers have been able to combat resistance actively, providing recommendations on resistance management for affected farmers by the end of the same season. Menne is helped in this task by his colleague Dr. Bernd Laber, a biochemist. Laber investigates the genetic material of the plant, using modern molecular biology methods, in order to detect signs of resistance. That saves valuable time: the faster the conclusive proof of resistance to a particular herbicide is found, the faster the Bayer researchers can give the farmers recommendations

to combat it. And these recommendations are urgently needed, since resistant weeds such as black-grass can mean the loss of entire harvests in the worst-case scenario, and therefore represent a threat to the food supply.

Tracking down enzyme mutations in DNA

The new method which Laber uses in his laboratory does not necessarily require seeds: it can be used on whole plants or even parts of plants. He is only interested in their DNA. The advantage is that farmers can send in potentially resistant weeds while the crops are still growing, without having to wait for them to run to seed at the end of the season. First, the DNA of the potentially resistant weeds is purified. Then Laber and his team put the genetic material under the microscope. "Most mutations which cause herbicide resistance are point mutations," explains Laber. That means that just one of many thousands of nucleic acid building blocks in the DNA for the enzyme targeted by the herbicide has mutated. However, the effect is far-reaching. The target enzyme is changed to the extent that the herbicide can no longer bind to it. The herbicide has no effect and the plant has become resistant. In his laboratory, Laber determines the order of the nucleic acid building blocks in a DNA sample and checks whether any of them have been replaced. "That way, we can see immediately whether a point mutation has taken place," he says.

Weeds can also become resistant if their metabolism changes in such a way that a herbicide is inactivated more quickly. These metabolic resistances are much more difficult to detect, however, because the resistance is caused by the production of any one of a large number of enzymes in far greater quantities than usual. Bayer's researchers are nonetheless optimistic that they will soon have an answer to this problem.

Using molecular biology techniques for analysis has already brought the scientists immense advantages. If the samples are sent in the form of seeds, Laber can provide data on the mechanism of resistance to supplement the results obtained by Menne by growing the seeds under glass. And if the samples are plant material, the researchers can use molecular biology analysis to determine even more quickly whether resistance exists: if Laber's tests for resistance turn out positive, then Menne can give the farmer comprehensive recommendations for plant protection before the end of the season.

Agriculture and the environment benefit equally

"Luckily, Bayer's product range has such a broad range of mechanisms of action that we can always give recommendations for effective resistance management," says Menne. Thanks to the Bayer experts' results, the farmer knows which herbicide will work best on this occasion, allowing him to tackle the weeds in question in a much more targeted manner. This not only generally saves the farmer money, but also benefits the environment.

www.weedscience.com
This Internet website maintained by various interest groups gives more information about the problem of resistance in crop protection.

Agricultural assistance: Dr. Bernd Laber (photo below, right) analyzes the DNA of weeds (photo, left) to track down the mutations responsible for resistance to herbicides. In parallel to this, his colleague Dr. Hubert Menne (photo below, left) conducts greenhouse tests to determine which agents are still effective and to which substances the weeds have become resistant. They then derive crop protection recommendations for farmers around the world from these data. This helps to safeguard harvests.