



Innovations to increase yield and secure the harvest

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# Agriculture for the future

Population growth, contracting agricultural surfaces, climate change and changing eating habits in newly-industrializing countries: responding to these trends will require new approaches to increasing agricultural productivity. Bayer CropScience's innovative solutions are helping farmers to meet the demands of the future.



*Research into new crop protection agents: broad beans being soaked in a solution of an active substance in preparation for tests with insects.*

of Bayer CropScience. “With a Research and Development budget of around 650 million Euros a year, and the efforts of 3,850 researchers, we are one of the world-leading innovative companies in the agricultural sector”, continues Berschauer. Bayer CropScience’s strategy rests on three pillars: chemical crop protection, plant characteristics – or “traits” – and high-quality seed.

### Innovative active substances

The teams of crop protection researchers already have some promising candidates in the pipeline. One of the most recent examples is the new active substance bixafen – an innovative cereal fungicide that is particularly effective against Septoria leaf spot and brown rust, and which also has a yield-enhancing effect. Market introduction is planned for various countries during 2010 and 2011. Two further fungicides are intended to enter the market in 2010 and 2011: isotianil, for use in rice crops; and fluopyram, which belongs to the new chemical class of pyridinylethylbenzamides. “Fluopyram is a very active fungicide that is particularly effective in controlling grey mould and powdery mildew”, explains Dr. Heiko Rieck, Project Manager for Bayer CropScience at Monheim. However, it is also effective against further fungal diseases capable of causing

**A**griculture is facing a big challenge: more food must be produced in the coming 30 years than was harvested in total over the last 10,000 years. According to the most recent report by the Food and Agriculture Organisation (FAO), more than a billion people are already suffering from undernourishment today – and the population is continuing to grow. Moreover, developments in world market prices for agricultural commodities are more and more strongly tied to the raw materials, currency and financial markets. This

means that farmers will not only need to be increasingly adroit in selling to forward markets: they’ll also need new approaches to protecting their crops and increasing productivity.

Bayer CropScience researchers are already offering innovative solutions today for the agriculture of the future: “We want to help farmers around the world to meet the ever-increasing demand for affordable, high-quality food and feed, plant fibres, and bio-fuels”, says Prof. Friedrich Berschauer, Chairman of the Board of Management



Marketing expert Dr. Albert Witzemberger (right) and Researcher Dr. Dirk Ebbinghaus are very satisfied with the results of the studies. Plants treated with trifloxystrobin are looking good.



substantial economic losses, such as sclerotinia and monilia-diseases. “Its ability to improve storability and to extend the shelf-life of the harvested commodities are further important advantages of particular benefit to food distributors, and of course, in the end – to the consumer”, says Rieck. This new active substance is suitable for use in more than 70 crops around the world, including wine and table grapes, pome and stone fruits, vegetables and arable crops.

On top of this, three further candidates find themselves in the later stages of development. The first is the biological control agent *Bacillus firmus*, which protects plant roots from attack by nematodes.

Equally new is the insecticide Movento®, which is already registered in several markets. Its entirely new mode of action helps to control pests such as aphids and whiteflies. Indeed, it has a kind of double-action, which is expressed via two transport routes – the active substance spirotetramat is distributed through both the xylem and the phloem – thus reaching tissues throughout the whole plant. Sucking insects such as aphids tap into the phloem – the plant’s channel for nutrients – and ingest the active substance. These properties mean that spirotetramat is even able to control pests situated in places that are otherwise inaccessible to treatments, such as the roots, or the innermost leaves of lettuce or cabbage heads. At the same time, use according to label recommendations ensures that bees and other beneficial insects are not at risk.



Investigating the distribution of an active substance on cereal leaves.

Researchers are also working on innovations in the area of seeds: this is an area in which Bayer CropScience will continue to extend its research activities, particularly through collaborative work with leading international research groups. To this end, the company has forged an extensive, long-term cooperation agreement with one of the world’s most important research institutions, the “Commonwealth Scientific and Industrial Research Organisation” (CSIRO), whose Headquarters is in Canberra, Australia. One of the joint aims is to develop new wheat varieties: covering around 25 percent of the area under agricultural crops, this is the most prevalent of all the cereals. The emphasis will be on achieving crops that are capable of higher yields, with increased

resilience and improved nutrient uptake. Some promising new solutions for wheat farming are on their way: the first could be made available as soon as 2015.

### Unravelling the rape genome

If the future demand for food is to be met, then it will be vital to improve productivity. Professor Dr. Martin Qaim of the Institute of International Food Economics and Rural Development at the University of Göttingen estimates that food production will have to almost double by 2050. “To achieve this, we’ll have to introduce new technologies such as genetic engineering to support conventional methods”, explains Qaim. For this reason, Bayer CropScience’s researchers are also taking advantage of the methods and possibilities offered by modern biotechnology. For example, the company has, together with other institutions, decoded the entire genome of the rape seed variety canola for the first time. This has provided Bayer with a unique insight into the hitherto hidden genetic code of the rape plant – which, with a 15 percent share of world plant oil production, is the second most important oilseed crop after soybean.

The researchers are already optimizing crop plants today using biotechnological methods, for example by making them more resistant to so-called abiotic stresses, which include long periods of drought, flooding, or extreme temperature variations. This is important because the plants' responses to these stresses take up enormous amounts of energy that they could otherwise use to drive vital physiological processes – such as growth and carbon fixation through photosynthesis. Researchers at Bayer CropScience's Innovation Centre for Plant Molecular Biology in Gent, Belgium, are therefore working on innovative ways of limiting this energy loss. In doing so, the researchers are following two strategies: firstly, they introduce useful genes capable of improving the ability of test plants to deal with extreme drought or flooding stress, in an attempt to increase yield. On the other hand, they silence individual genes, which – in the normal plants – would trigger an excessive stress response likely to diminish yield. In fact, the scientists are not aiming to achieve the maximum yield. What's important to them is to achieve the right mix of several favourable characteristics. "We want to endow the plants with the ability to produce sustainable, high yields under variable environmental conditions," says Michael Metzloff, a Molecular Biologist working for Bayer CropScience in Gent.

### More resistant to abiotic stress

And that is urgently needed, because "abiotic stress factors can cause severe yield losses, sometimes of up to 80 percent", says Dr. Dirk Ebbinghaus, Crop protection researchers at Bayer CropScience. This is why scientists are also investigating conventional crop protection agents for additional benefits in terms of improved stress tolerance – with some success. They have discovered that the insecticidal active substance imidacloprid makes plants more resilient. In field trials, plants treated with the Bayer compound grew significantly better than untreated plants. "What is also surprising is the fact that imidacloprid-treated plants produce sig-



Mosquito nets against malaria: prevention is better than cure.

### Spirit of research against tropical disease

*Bayer CropScience isn't just doing innovative work in relation to the search for active substances for agriculture. Within the framework of its activities in the area of public health, the company is working hard to help towards the control of malaria – one of the most dangerous of tropical diseases. Each year, more than 880,000 people are killed by the parasite, which is transferred by the Anopheles mosquito. The most important form of protection – a fine net. Bayer CropScience researchers have found a way of incorporating the insecticidal active substance deltamethrin into the polypropylene fibres of the nets. In this way, they provide long-term protection against the mosquitoes for people in tropical areas.*

nificantly greater amounts of defence proteins that are capable of protecting them against fungal pathogens. This effectively means that imidacloprid not only shows its proven insecticidal qualities, but it also plays an additional supporting role in protecting the plant against fungal infection and stress", explains Dr. Wolfgang Thielert, agronomist and crop protection researcher at Bayer CropScience.

Trifloxystrobin, a well-proven strobilurin fungicide that has been protecting cereal, vegetable and fruit crops against damaging fungal infections for some years, has shown similar results. "Field trials clearly show that crops treated with strobilurins produce higher yields than those treated with fungicides from other classes", reports Dirk Ebbinghaus. Scientists have also discovered that cereal crops produce more starch and protein after treatment with strobilurins. The reason: "The strobilurins stimulate not only photosynthetic efficiency – and thus starch production – but also nitrogen assimilation, which provides

the basis for protein synthesis", continues Ebbinghaus. Wheat plants treated with this compound are able to use the nitrogen available in the soil particularly efficiently.

For Dr. Rüdiger Scheitza, the member of the Bayer CropScience Board of Management responsible for Portfolio Management, innovative crop protection is an essential element of a productive and competitive agriculture: "It's a precondition for being able to provide the consumer with high-quality, healthy and safe food at appropriate prices, whilst working the land in a sustainable way – i.e. sparing the environment and resources". And using a combination of modern technologies such as high-throughput screening and genomics alongside classical chemistry and biology, Bayer CropScience's researchers are able to produce a steady stream of new, innovative solutions. Meaning that farmers around the world are being provided with a good basis for secure harvests and high yields – now, and well into the future. ◀