

Active ingredients from Bayer are protecting agricultural products

Strategies for healthy harvests





Keeping an eye on the tiny enemy: Dr. Thomas Bretschneider (left) and Dr. Ralf Nauen view macroscopic images of whiteflies. The hungry pests pose a global threat to the agricultural industry. So does the spider mite, which covers crops such as beans (large photo) in a delicate tangle of threads and is capable of destroying entire fields.

The world's burgeoning population requires not only basic foodstuffs but fare that is rich in vitamins and minerals as well. Yet vegetable and fruit farmers around the globe are faced with a growing problem: pests that attack crops have skyrocketed in number and developed resistances to many common crop protection agents. Researchers from Bayer CropScience are now coming to the farmers' aid with an entirely new arsenal of strategies.

Around the world, farmers who grow fruit, vegetables and potatoes are facing ever increasing problems. In the past several decades, many pests and harmful fungi that attack crops have spread to nearly all continents of the world and are rapidly multiplying. Three of these pests alone – the tobacco whitefly *Bemisia tabaci*, also known as the "sweet potato whitefly", as well as certain types of spider mites and the fungus *Phytophthora infestans* which induces late blight – are now causing billions of dollars' worth of damage. In extreme cases, says Dr. Hubertus Schulte of Bayer CropScience, "an infestation of these organisms can lead to loss of the entire crop."

There are many crop protection agents targeting pests, but in several regions of the earth a number of pests have already become resistant to conventional products. Bayer researchers have therefore long been searching for new substances capable of combating even these tough parasites. This is no easy task, as the substances must not only be as effective as possible, they must also be nontoxic to humans, the environment and beneficial organisms. As a result, chemists and biologists often spend more than ten years

experimenting in the lab before they can present farmers with a new crop protection agent.

Thanks to intensive research and a whole host of chemical tricks, however, the team around Dr. Reiner Fischer and Dr. Thomas Bretschneider at Bayer CropScience in Monheim has been able to develop the new and highly innovative crop protection agent Oberon® and ready it for market.

Effective against pests yet nontoxic to beneficial organisms

Effective against pests and nontoxic to beneficial organisms, Oberon® is already in demand around the globe. The mode of action in this product is different from that in previously available crop protection agents. It thus also helps combat all those pests that display a resistance to the other insecticides currently on the market.

At the same time, Oberon® has a favorable profile for users, consumers and the environment: numerous trials in the laboratory and test fields have proven that Oberon® leaves virtually no residue in the field or on the product. All

of these plus points led to the product being granted reduced-risk status by the American Environmental Protection Agency (EPA), thus expediting product approval (see box: "Special status for environmental protection").

In addition, Oberon® is also nontoxic to a large number of beneficial animals – those organisms that naturally keep pests in check by eating them or preventing them from multiplying. Thanks to Oberon®, farmers can now practice the optimum combination chemical and biological pest control: while the active ingredient from Bayer inhibits the spread of whiteflies and spider mites, beneficial organisms attack pests not targeted by Oberon®.

The urgent need for this type of multi-approach strategy is clearly exemplified by the whitefly, a true survival artist. Over the course of the past several decades, the tiny insect weighing just 20 thousandths of a milligram has become one of the most severe agricultural pests worldwide. Despite its tiny size, it is spreading quickly. And that's not all. "The types of insects which are now multiplying in mass quantities are also more difficult to

Special status for environmental protection

In developing improved active ingredients, manufacturers of crop protection agents around the globe are working on finding substances that pose as little risk as possible to humans and the environment. In the early 1990s, the U.S. Environmental Protection Agency (EPA) began purposefully promoting the use of these types of low-impact crop protection agents. Thanks to the reduced-risk status introduced by the EPA in 1993, expedited approval of substances is possible when manufacturers can prove that the agent is safer and gentler to the environment than other products already on the market. Every year, numerous manufacturers apply to the EPA for this reduced-risk status for their products. Only a small fraction of them actually receive it, however. Of the 162 applications for substances used in food production, only 40 were granted this status by the Environmental Protection Agency in 2006 – including the Oberon® insecticide from Bayer CropScience.

combat," says Bayer biologist Dr. Ralf Nauen. The Q-type whitefly has now appeared in large numbers in many countries for the first time. As a result of biochemical differences, this subspecies inherently develops much stronger

resistances much more quickly than the B-type with which farmers were previously confronted.

Until 2003, the more aggressive Q-type was found almost exclusively in Spain. Since then, however, it has

spread first to the area around the Mediterranean and later around the entire globe. It was found in the United States for the first time in 2004. The Q-type has now reached New Zealand and Japan, where it has almost completely supplanted the B-type. "The problem is so severe in the United States that the responsible authorities have formed a task force specifically to combat the whitefly," says Nauen. "Among other things, this task force is designed to prevent the spread of the whitefly through measures such as recommending innovative products like Oberon."

The whitefly attacks more than 500 kinds of plants

Virtually no crop today is safe from attack by whiteflies. After all, the tiny insect is extremely versatile. In addition to tomatoes, peppers, cucumbers, melons, cotton and soy beans, *Bemisia tabaci* has an additional 500 plants on its menu. The insects attack all of these plants in several different ways at the same time. Both the larva and the adult insect attach themselves to the underside of the leaves where they tap the plant, draining its sugary phloem juice.

Pest control: Dr. Hubertus Schulte (left) and Dr. Reiner Fischer check cucumber plants for infestation by whiteflies in the greenhouse. After being killed, the pests are collected from the plants for further study regarding the efficacy of Oberon® (right).



Part of this juice is then excreted by the insects again, forming a sticky honeydew on the leaves and fruits which can significantly impair the quality of the harvest. Black spot or rust fungus can then settle on the sugary fluid, rendering the fruit unsightly and thus difficult to sell.

The development of Oberon® provides farmers with a crop protection agent that shares no cross-resistances with any of the currently available insecticides. Its active ingredient, spiromesifen, inhibits an enzyme important in the formation of essential fatty acids. Soon after being exposed to this agent, pests are unable to form fats.

This alteration in their metabolism has multiple effects on the insects' reproduction and growth: as soon as the host plant is sprayed with Oberon® and the animals come into contact with the active ingredient, the percentage of fat in full-grown whiteflies significantly decreases. After just a brief time, the females are unable to lay eggs or lay only sterile eggs from which no larva will hatch. Oberon® impacts other phases of development as well. Up to 100 percent of all larva die after exposure to the new agent. In addition, Oberon® is successful at combating a large number of spider

mites which also cause severe damage in the agricultural industry.

Despite all the advantages, a new development like Oberon® alone cannot solve the problem of resistance formation in whiteflies. This organism is much too flexible and adaptable for that. One reason for this is the whitefly's rapid reproduction rate. Three to four weeks are all that is needed for transformation from egg to adult insect. In the long term, safeguarding high-quality fruit and vegetable harvests therefore depends mainly on clever resistance management. "Instead of just using Oberon from now on," says Nauen, "it may in many cases make better sense to alternate each season with a crop protection agent that has a different mode of action." The development of these kinds of strategies, which require adaptation to the respective local growing conditions, has long been one of Bayer CropScience's fields of expertise and a recipe for its success, adds the biologist.

Alexander Buschermöhle, Product Manager Infinito® at Bayer CropScience in Monheim, has one new product with this sustainable resistance management already built in: the crop protection agent Infinito® safeguards potatoes and

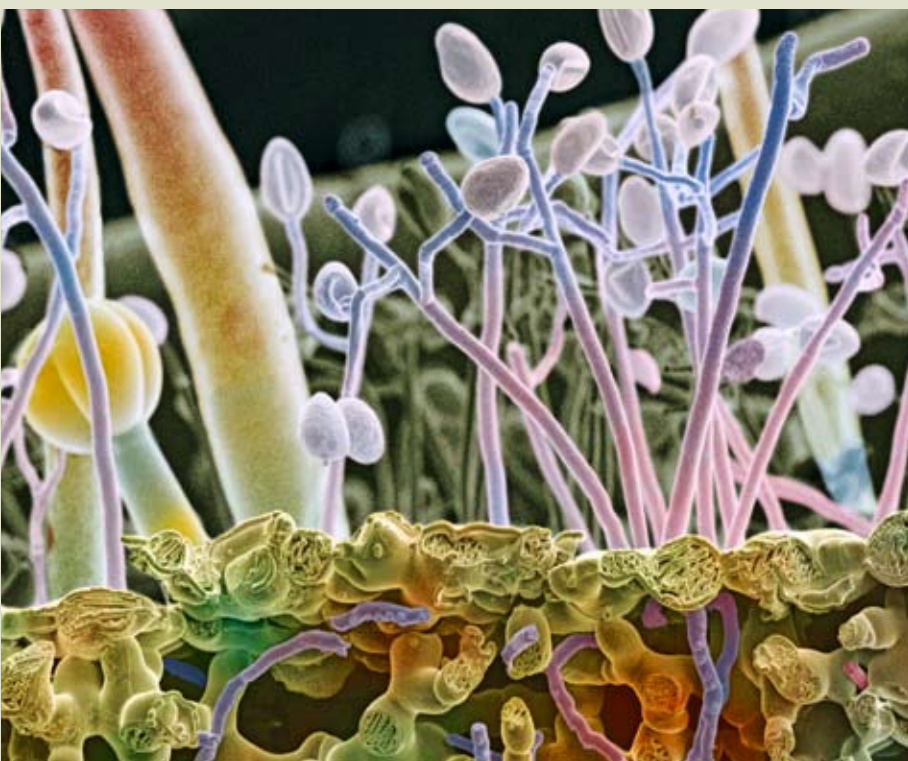
a number of other vegetables against damage by the late blight fungus *Phytophthora infestans* and other dangerous pathogens. It contains a mixture of two different active ingredients.

New active substance combination protects against late blight

One of the two substances is a totally innovative form of disease control, the first active ingredient from a new generation of fungicides, the acylpicolides. The compound, known as fluopicolide, attacks the late blight pathogen and thwarts even resistant strains of the fungus with its innovative mode of action. The primary targets of the active ingredient are the zoospores which serve as the reproductive unit for the fungus. Even when applied in very weak concentrations, it kills the germs, rendering them unable to move within a matter of seconds. A short time later, they swell up and then explode.

In addition, fluopicolide blocks the growth of the mycelia – the fine, thread-like network that the fungus uses to spread itself in the plant tissue. As compared to other active ingredients, fluopicolide is especially unique for its long-lasting, effective protection against

Late blight: the harmful fungus *Phytophthora infestans* forms its threadlike network in the tissue of the potato plant. The Bayer active ingredient fluopicolide primarily targets the zoospores (contained in the capsules at the end of the threads) which the late blight fungus requires for reproduction.



Infinito® is becoming a European standard

A group of leading scientists has formed a European expert group to share their experience and research findings on protection of potatoes against diseases as well as to evaluate the efficacy of the available crop protection agents. These independent specialists declared Infinito® the best product available, even before it was officially launched on the market. In May 2007, the group confirmed and upgraded this assessment. Infinito® is thus becoming the backbone of potato protection strategies in agriculture.

the disease and even functions in different climatic conditions worldwide. The second partner in the line of fungus defense is the substance propamocarb HCL. This tried-and-proven active ingredient has been on the market for some 30 years now and complements the newcomer perfectly. Each substance attacks *Phytophthora infestans* in a different development stage with a different mechanism. In addition, propamocarb HCL improves penetration of fluopicolide into the leaves and stalks. All in all, this makes Infinito® more effective and effective for a longer period of time than other fungicides.

In the future, Infinito® could thus advance to become one of the most important protection agents for crops. Thanks to its versatility, the potato is one of the most important human food crops.

Environmentally friendly protection for potatoes worldwide

To the distress of farmers, however, pests such as *Phytophthora infestans* are also fond of this plant, originally a native of Latin America. Once late blight has infested a field, the first symptoms

soon become visible to the naked eye: gray-green spots form on the edges of the leaves and spread inward, later turning brown and rapidly increasing in size when the weather grows damp. A white carpet of fungi grows on the underside of the leaves. The leaves dry out or rot, while the tubers remain small and stunted. Late blight is the most severe disease to affect this plant anywhere around the world. The year 2007 saw one of the worst infestations in centuries as a result of weather conditions, further underscoring the importance of prophylactic disease protection.

Things become especially problematic when the tuber itself is infected. During the typical month-long storage process, the affected potatoes not only become moist and soft, they are also more susceptible to infection by bacteria. They can then no longer be processed. "In time, the disease spreads to the entire stock," says Buschermöhle. Covered in blue-gray spots, the potatoes

are then inedible and their flesh ultimately turns brown and rots. *Phytophthora* can even survive the winter in the tubers. Just one infected tuber planted in spring can trigger an epidemic in the entire potato-growing region.

Thanks to its unique combination of active ingredients, Infinito® prevents infestation of the leaves and thus lastingly protects against potential infection of the tubers. Combined with new application strategies, this improves tuber quality and storability. Infinito® thus makes it easier to provide a supply of potatoes year-round.

Because it is also safe for humans and has no negative impact on bees, birds, earthworms and insects, Infinito® is becoming the standard in integrated crop production. In addition to the approvals in the United Kingdom, China, Germany, the Netherlands and other countries, Buschermöhle expects successful marketing in all major potato- and vegetable-growing countries worldwide.

www.epa.gov/pesticides/factsheets/ipm.htm



A website from the U.S. Environmental Protection Agency on integrated crop protection, food production and sensible use of pesticides.

Research in the field: (left to right) Alexander Buschermöhle, Dr. Thomas Wegmann and Sylvain Tafforeau review the efficacy of the antifungal agent Infinito® in a potato field. In extreme cases, fungi like late blight can infest huge cultivation areas and destroy entire harvests (right).

