Fruit under attack: the citrus greening bacterial disease has led to dramatic harvest losses on citrus plantations in many parts of the world. It is causing particular concern among orange-growers in Florida, as the disease is spreading at a rapid pace.
Once afflicted by yellow dragon disease, a citrus tree is doomed. Its leaves turn yellow and its fruit stays green, fails to ripen and tastes bitter. The roots of the tree rot away, and the plant dies within just a few years. Yellow dragon disease, also known as citrus greening, is ruining more and more orange plantations in Brazil and the United States, two of the most important citrus-producing countries. Originally from Asia, the bacterial pathogen has been spreading for more than ten years, causing dramatic losses in yield and fruit quality. The situation is especially difficult for orange growers in Florida, the third-largest producer of oranges after Brazil and China. "More than 90 percent of commercial plantations in Florida are now affected by citrus greening," explains Kai Wirtz, Global Crop Manager Fruit at Bayer CropScience. The plant disease is spreading rapidly, reducing the productivity of citrus trees. Affected orange trees bear less fruit, and the quality of the fruit they do produce is low – fruit production becomes economically inviable within just a few years. "If our worst fears come true, Florida’s harvest for the 2014/2015 season will be only 3.7 million tons," Wirtz explains. That means just 90 million boxes filled with oranges. By way of comparison, the state filled 242 million boxes ten years ago.

Tiny insect transmits the dangerous bacterium that damages citrus trees

A tiny insect, the Asian citrus psyllid, is the reason that more and more citrus trees are succumbing to yellow dragon disease. The pest transmits the deadly disease to citrus trees in all stages of its life. Even the young psyllids, known as nymphs, spread the pathogen. "The nymphs are hardly big enough to see – even the adult insects are only the size of a pin head," Wirtz says. When the insects attack an infected citrus tree to suck its sap, they take up the bacteria Candidatus Liberibacter. The psyllids then move on to the next tree, transmitting the dangerous pathogen into the phloem, an important nutrient transport channel in plants that moves sugar molecules and amino acids from the leaves to the storage tissue and fruits. "The infection severely limits this flow of nutrients. The oranges, lemons and grapefruits do not grow or ripen as they should, and any fruits that do form are small and sour," explains the fruit crop specialist from Bayer. In just a few years, the plant is so badly weakened that it dies.

"At present, there is no method capable of curing the bacterial disease," Wirtz explains. Researchers at Bayer have therefore joined forces with other scientists in an international network to focus on combating the carrier of the deadly disease. "The psyllid must be kept at bay," Wirtz emphasizes. "In some cases, pesticides can help. But for the long-term strategy, we need to develop biocontrol agents that prevent the insects from spreading the pathogen. Bayer CropScience is providing support to this initiative." The plant disease is spreading rapidly, reducing the productivity of citrus trees. Affected orange trees bear less fruit, and the quality of the fruit they do produce is low – fruit production becomes economically inviable within just a few years. "If our worst fears come true, Florida’s harvest for the 2014/2015 season will be only 3.7 million tons," Wirtz explains. That means just 90 million boxes filled with oranges. By way of comparison, the state filled 242 million boxes ten years ago.

2.3 million orange trees would have to be planted each year in Florida to halt the dramatic decline in orange harvests.

Source: United States Sugar Corporation

Kai Wirtz is working with experts from Bayer and external partners on solutions that target the vector of citrus greening.

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lids mature very quickly. They take just 17 days to develop from an egg to the adult insect. The psyllids produce eight to nine new generations each year. If conditions are ideal, they may produce as many as 30 generations,” says the Bayer specialist. In February 2015, the psyllids were identified in Spain and Portugal for the first time. “These insects were not yet carrying yellow dragon disease, but we are afraid that the occurrence of citrus greening in Europe is just a question of time,” Wirtz explains.

At present, citrus growers’ options are limited to monitoring the psyllids and regularly inspecting their plantations to check their trees for yellowed leaves – the first sign of citrus greening. However, “precise diagnosis is difficult because the disease often becomes apparent only at an advanced stage,” says Wirtz. Laboratory DNA analysis is the only certain means of confirmation. Once the disease is confirmed, all growers can generally do is destroy the afflicted orange trees and plant new ones to maintain their stock. American citrus growers are attempting to protect the edges of their plantations with systemic insecticides to stop the insects at the perimeter. These agents – such as the new Bayer insecticide Sivanto™ – work from inside the plant and help to reduce the psyllid population. “One big advantage of Sivanto, for example, is that it is non-hazardous to most beneficial insects if used correctly and can therefore also be used flexibly in terms of application timing,” Wirtz says. However, even highly effective insecticides are not enough to stop yellow dragon disease on their own. The Food Chair Partnership team of Bayer CropScience has therefore launched an initiative to

ат strategy to counter bacterial vectors

At present, there is no way to cure orange trees of citrus greening. Bayer scientists and their partners are therefore concentrating their work on controlling the vector of this plant disease: the Asian citrus psyllid spreads the bacterial pathogen from tree to tree.

1 The phloem of plants transports vital nutrients such as sugar and amino acids from the leaves.

2 Adult psyllids and their offspring (nymphs) feed on the leaves of the orange tree. This spreads the bacterium Candidatus Liberibacter into the phloem,

3 The infection blocks the phloem. The nutrients can no longer get to the fruit, the oranges cannot grow and mature properly: they turn green and the leaves turn yellow.

The different approaches being pursued by Bayer experts:

- Crop protection agents help to stem the spread of the psyllids.
- The psyllid’s natural enemy Tamarixia radiata parasitizes psyllid nymphs.
- Anti-bacterial solutions may be able to selectively combat the bacteria in the long term. This may also make it possible to cure infected plants.
search for additional solutions to combat the devastating disease, joining forces with big players in the juice industry. The crop protection experts are aiming to make orange trees more resistant to the disease with the tried-and-proven Bayer active substance fosetyl-aluminum. This is the active component of the fungicide Aliette™, which is used to treat apples, pears and grapevines. “We use it, for instance, to immunize the young plants and strengthen their defense systems,” says Dr. Christoph Andreas Braun of Product & Project Support Disease Control, Bayer CropScience. In the coming years, researchers want to use the active substance to help citrus plants as well. Bayer is not limiting its efforts to just professional citrus growers. In California, specialists from Bayer are also teaching residential fruit growers how to manage the insect pest to help keep Californian citrus trees free from the disease. Together with California Citrus Mutual, Bayer has founded an initiative called Citrus Matters to promote education of backyard citrus growers.

“Commercial citrus growers in California are able to manage the psyllids and monitor their groves regularly. But the threat to their plantations remains in place if citrus greening infects the countless citrus trees in people’s yards,” says Wirtz. The goal of the campaign is to make homeowners who have citrus trees on their property aware of the dangers posed by the disease and to enable them to help stop the spread of the Asian citrus psyllid in California.

Scientists working with partners worldwide to develop solutions to citrus greening

In order to effectively combat citrus greening, citrus growers must prevent their trees from becoming infected with the bacteria in the first place. That is easier said than done. “You have to kill the psyllids before they feed on the sap and are able to transmit yellow dragon disease,” Wirtz explains. Bayer researchers therefore have to become better acquainted with the pest. The first step: careful monitoring of the psyllids and the pathogen. Bayer and its external Food Chain Partners therefore plan to join forces to create “model farms” in Florida and other growing regions in Latin America. “A holistic approach will be crucial for effectively controlling citrus greening in the future,” Wirtz says. But Bayer’s specialists have also set their sights on another long-term goal: highly specialized antibacterial solutions to combat citrus greening. Initial tests are already under way.

Bayer specialists are also supporting research to use the psyllids’ natural enemy, Tamarixia radiata, to combat them. This wasp lays its eggs on the psyllid nymphs. When the wasps hatch, they feed on the young psyllids, thus reducing the population of the disease vector. In Brazil, Bayer CropScience is supporting placement of breeding stations for this species of wasp in private orange groves, and the first field tests of this form of biological pest control are now being conducted in commercial plantations. As yet another approach, Bayer has teamed up with researchers in California and São Paolo to develop pheromone traps, which use female sexual pheromones to attract the male psyllids. “In the future, we may be able to develop selective traps and substantially reduce the population of psyllids,” explains Dr. Peter Lösel, an insect physiologist in Pest Control Biology at Bayer CropScience.

Around the globe, Bayer scientists and their research colleagues are working together to develop integrated measures to combat citrus greening and tame the yellow dragon.