RISE TO THE CHALLENGE: COTTON

Two bioscience firms, Bayer CropScience and Performance Plants Incorporated, are teaming up to apply drought-tolerance technology to cotton.



Time for cotton to toughen up

Bayer CropScience AG is to work with Canadian biotechnology firm Performance Plants Incorporated (PPI) to develop and commercialise cotton that can survive and thrive in times of drought.

The National Cotton Council of America lists China, India, the US, Pakistan, Brazil, Uzbekistan, Australia, Turkey, Turkmenistan and Syria (in that order) as the world's top cotton-producing countries in 2009 and, of these, at least five have experienced severe drought conditions in the course of last year. This confirms the view of the two bioscience companies that cotton capable of withstanding extreme dryness will be of value to many growers.

The new agreement follows several years of field trials carried out by Performance Plants, which have shown that its Yield Protection Technology (YPT)—the technology it proposes to use in the joint venture with Bayer—to be effective in preserving yields under conditions of what the Canadian company calls "drought stress". In some tests involving plants other than cotton, crops produced using YPT have been 26% better. "Our results and those of other partners we work with continue to show the yield-protecting benefits of our drought-tolerance technology. We are pleased that Bayer CropScience will now extend these results to cotton, a crop whose yield is frequently limited by insufficient rainfall," said Peter Matthewman,

Research in the new Bayer CropScience plant health laboratory in Lyon focuses on new technologies to improve the climate tolerance of major crop plants, including cotton.

Bayer CropScience

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the company's chief executive.

This is a tacit admission that Performance Plants' focus with YPT until now has been on food and biofuels. The company's director of business development for biofuels (and of media relations), Dr Kevin Gellatly, explains that YPT technology can improve the natural drought tolerance properties of many plants; he says the key is a gene that is found in all plant species, farnesyltransferse. "Since cotton can greatly benefit from drought tolerance, Bayer CropScience and PPI decided to apply the technology to cotton," he explains. "So, although we are just beginning our work on cotton, we have extensive data from other plant species. This gene, farnesyltransferse, is not expressed in seeds and will have no impact on seed quality or the cotton fibre that grows."

The science behind the idea

Going into the technical side of this in slightly more detail, Dr Gellatly explains: "Our YPT technology involves developing plants that have a reduced level of farnesyltransferase enzyme activity in their leaves. The role of farnesyltransferase is to act as a negative regulator of the plant's drought response."

Normally, a plant draws carbon dioxide into its leaves through small pores in its leaves, called stomata, for photosynthesis, the process through which plants convert carbon dioxide into organic compounds, especially sugars, using the energy from sunlight. However, when the stomata are open, it also makes it easier for a plant to lose water. This process, called transpiration, can lead to wilting, and when plants begin to wilt, its leaf cells send out a hormonal signal in the form of abscisic acid telling the stomata to close so that the transpiration stops.

"Farnesyltransferase normally acts to reduce the sensitivity of the 'close stomata' signal," Dr Gellatly continues. "With reduced farnesyltransferase expression, the signal triggers stomatal closure much faster and this helps the plant avoid the severe yield losses normally accompanying drought stress. Therefore, YPT plants with low levels of farnesyltransferase are better equipped to avoid drought stress.

"Upon re-watering after a drought spell, YPT plants will have retained more moisture and are able to kick-start growth faster compared to unimproved plants. In many years of field trials, YPT canola has consistently produced higher seed yields. In the petunia, we see significantly greater flower retention in response to drought stress. These results suggest YPT cotton seed and fibre yields will increase or could possibly need less irrigation compared to unimproved plants."

The mechanism behind YPT technology has been subjected to substantial peer-review research.



A drought-affected paddock near Uranquinty, New South Wales, Australia, one of the major cotton-producing countries affected by severe drought in 2009.

Bidgee/Wikipedia

A range of cotton enhancements

At Bayer CropScience, global cotton research and development manager, Dr Linda Trolinder, says her company has already contributed a number of enhanced cotton seed varieties that have helped farmers around the world. This branch of the Bayer group focuses entirely on crop protection, non-agricultural pest control, seeds and plant biotechnology. Its chairman, Dr Friedrich Berschauer, confirmed at the company's annual press conference last September that cotton, along with rice, rapeseed, soybeans and corn, is part of the group of core crops the company has decided to concentrate on. There is a simple reason for this: money.

"We have a well-filled pipeline in bioscience, which comprises our activities with seeds and plant traits," he said. "The traits currently in development at Bayer CropScience cover solutions for cotton, rapeseed, rice, soybeans and corn. We are planning to launch 14 seed varieties with innovative traits in these crops between 2008 and 2016 and expect a combined revenue potential of about €500 million."

He went on to show just how important cotton is within this strategy. He explained: "With our research, we want to make a contribution to ensuring that farmers around the world can utilise a larger selection of high-performance trait solutions. We are therefore developing new solutions, for example for herbicide tolerance, stress tolerance and resistance to insect pests and plant diseases. It is becoming increasingly important to combine these different solutions into what are termed stacks. For example, next year 2010 we will be the first company worldwide to offer cotton seed with an in-built tolerance to the two leading herbicides, glyphosate and glufosinate-ammonium, thus giving farmers more freedom in the selection of the crop protection solutions they can use." The year after that, Dr Berschauer went on, Bayer CropScience intends to equip

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this cotton with additional protection against the most important insect pests.

Green genetic engineering

He used the term "green genetic engineering methods" to describe the work Bayer CropScience is doing in this area. Within that, there is a programme devoted to cotton, Target 400. So far, more than 5,000 farmers in different parts of the world have been able to increase their productivity and profitability by taking part in this programme, the company states, which includes credit facilities for growers in developing countries. "With this holistic approach, we are systematically helping to improve rural development," Dr Berschauer said.

Growers are looking for flexibility, he pointed out. While prices for cotton have gone up since the beginning of this year, the prices for wheat and corn have dropped. This naturally affects farmers' decisions on which seeds, crop protection agents and fertilisers to spend money on, and the volatility has led farmers in some regions to postpone their purchasing decision in the hope of more favourable prices. "The crop protection industry has felt this reticence more and more as the year progresses," he concluded. The industry, therefore, is making every effort to increase the options available to growers in particular areas.



Bayer CropScience aims to develop cotton plants that produce high-quality fibres and are at the same time ideally suited to their location.

Bayer CropScience

Starting in 2012, Bayer CropScience plans to bring to market cotton varieties from its research programme that have a "double stack", producing two different substances against insect pests. "That means that in the future we will be able to market a unique product with four traits: a double herbicide-tolerant and double insect-resistant stack," the chairman said. And soon, this list of properties will also include resistance to drought.

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