IAEA, FAO help develop bananas resistant to major fungal disease

Field trials showing the new TR4-resistant banana variety, ZJ4, compared to the susceptible BaXi grown in Guangdong, China.
(Photo: G. Yi/Guangdong, China)

Bananas may be the world's favourite fruit, but plantations worldwide are increasingly under threat from a new fungus that destroys banana plants and endangers both the farmers' livelihoods and the industry.

Confined to Southeast Asia for decades, Fusarium wilt tropical race 4 (TR4) was spotted for the first time in Africa and in Latin America in 2019. Its outbreak in Colombia in August 2019 led to the declaration of a national emergency.

The IAEA — in cooperation with the Food and Agriculture Organization of the United Nations (FAO) — has worked with researchers worldwide to support the development of new varieties of banana species that could be resistant to the disease.

"Modern bananas can't grow seeds and so are difficult to improve using cross breeding," said Ivan Ingelbrecht, Head of the FAO/IAEA Plant Breeding and Genetics Laboratory. Therefore, the use of techniques such as irradiation or chemical mutagenesis to produce new varieties with favourable traits is often a favoured option to combat the disease.

After years of research, Chinese experts have released a new variety of Cavendish banana — the most commonly exported banana — that is resistant to TR4. The new variety was developed using chemical mutagenesis techniques, and other countries, including the Philippines, are in the advanced stages of developing their own varieties using gamma irradiation, Ingelbrecht said.

Fusarium wilt has been a major constraint to banana production for over a century. The disease is caused by a soil-borne fungus called Fusarium oxysporum f. sp. cubense. The pathogen remains viable in the soil for decades and is therefore difficult to eradicate. TR4 is a new strain of this fungus that has recently emerged. "The fungi enter susceptible plants through the roots and interfere with the uptake of water, causing wilting of the leaves, and the banana plant eventually dies," explained Ingelbrecht.

The FAO estimates that the annual direct damage caused by TR4 in Southeast Asia reaches about US $400 million, excluding indirect socio-economic impacts.

"The release of a new Cavendish variety will benefit many farmers; this success is due to the close collaboration with the IAEA and the FAO on mutagenesis techniques," said Yi Ganjun, Vice President of the Guangdong Academy of Agricultural Sciences in Guangzhou. "This state-of-the-art technology has resulted in a remarkable breakthrough in combatting Fusarium wilt."

"The exciting results of a new 'local' banana variety, which is resistant to Fusarium wilt TR4, gives tremendous hope to banana farmers who have successfully tested the new plants in

field trials," said Yi. "Mutagenesis techniques can contribute to the development of new banana plants to suit local environmental conditions."

The new variety is now being multiplied and distributed to other provinces. Chinese experts are willing to help their colleagues in other countries to develop varieties of banana that are resistant to TR4 and are suited to their climatic and soil conditions, Yi added.

Scientists are using in vitro techniques to grow thousands of small banana plants in test tubes that are suitable for mutagenesis using chemicals, gamma rays or X-rays. These techniques speed up the natural process of mutation in plants and create genetic diversity that can then be used to produce new varieties, including those with favourable traits. A coordinated research project involving scientists from six countries, including China and the Philippines, has spearheaded work on developing banana types with resistance to TR4 since 2015.

Plant breeders at a banana plantation with the new Cavendish varieties grown in Guangdong, China.
(Photo: G. Yi/Guangdong, China)

"The success achieved using chemical mutagenesis and the promising progress using irradiation in several Asian countries suggests that developing new, TR4-resistant varieties will be possible in the not-too-distant future in other parts of the world as well," Ingelbrecht said. "The IAEA and the FAO are committed to helping countries get there."

— By Miklos Gaspar

Fighting air pollution with a $1 tool

A simple new device that costs less than US $1 to make could help global efforts to reduce harmful air pollution caused by ammonia emissions, while also improving access to food. The small plastic tool was designed by Brazilian scientists in collaboration with the IAEA and the Food and Agricultural Organization of the United Nations (FAO). After isotopic techniques were used to test and confirm its accuracy, the tool is now being rolled out to help countries monitor and better manage ammonia emissions from agriculture, including the livestock industry.

Ammonia — a compound of nitrogen and hydrogen — is one of the major by-products of agriculture and is a gas released when, for example, fertilizers and animal manure breakdown. The presence of this gas (NH3) in the atmosphere can act as a secondary source of nitrous oxide (N20) — a powerful greenhouse gas — and can damage ecosystems by exacerbating water pollution, as well as causing health problems in people.

When fertilizer is not correctly applied, up to half of its nitrogen could be lost to the atmosphere, a loss which also has major financial consequences. Understanding this loss is essential for issuing recommendations to farmers on how best to manage their fertilizer use, which can help maximize productivity and benefits.

"On average, 35% of the nitrogen fertilizers used in Brazil are lost to the atmosphere as ammonia, which has a big impact on the environment and the economy," said Segundo Urquiaga, a soil scientist at the National Agrobiological Research Centre of the Brazilian Agricultural Research Corporation (Embrapa).

As the world population continues to increase, the demand for food grows with it. This, in turn, leads to expanding livestock industries and an increasing dependence on synthetic and organic nitrogen fertilizers for food production. It also means more ammonia emissions. This trend is expected to continue over the next decade and poses a threat to people's health and to the environment

Experts in countries such as Brazil are looking for ways to measure and mitigate the release of ammonia into the atmosphere. Many sophisticated methods, such as wind tunnels, cavity ring down spectroscopy and micrometeorological techniques, are already available, but they are expensive and require highly skilled field technicians to operate them.

"Measuring and mitigating this process has been laborious, time consuming and relatively expensive in the past," said Urquiaga. "This new technique is cost-effective, fast and can be adopted