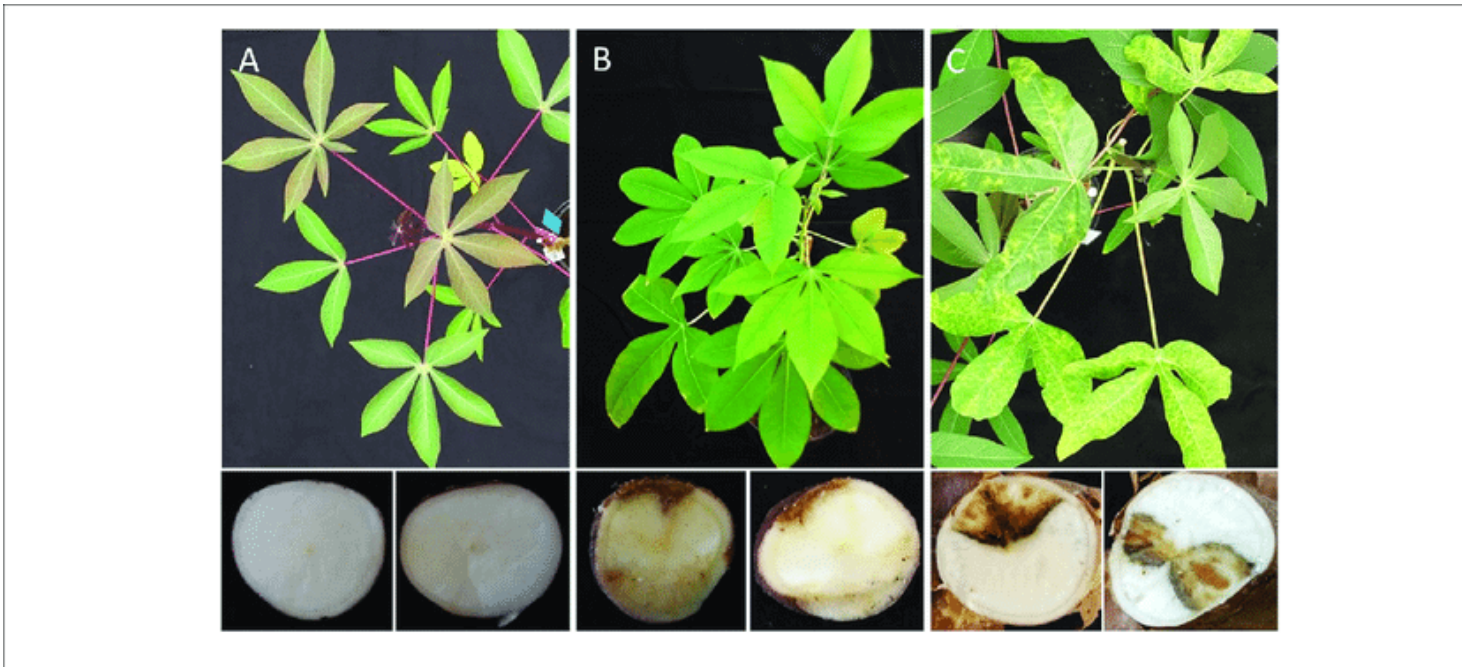
CRISPR tackles deadly cassava mosaic virus disease

Work has begun to possibly develop CRISPR cassava varieties that are resistant to the deadly cassava mosaic disease (CMD), after an international team of research scientists managed to identify a gene responsible for the resistance.

The team, led by Wilhelm Gruissem, a professor of Plant Biotechnology at the Swiss Federal Institute of Technology in Zürich (ETH Zurich), finally pinned down the gene responsible for what is known as the cassava mosaic disease 2 (CMD2) resistance in some cassava cultivars. Working with several resistant and susceptible West African cassava cultivars, the team used elaborate and time-?consuming genome analyses to identify the gene responsible for a specific resistance to cassava mosaic virus. The research team included scientists from National Crops Resources Research Institute in Uganda, Donald Danforth Plant Science Center in St. Louis, Missouri, and the University of California, Los Angeles.

The gene that has been identified now serves as a genetic marker for breeders, indicating whether the resistance is present in their plants, and can be used in guiding development of resistant varieties. In an interview with the Alliance for Science, Gruissem explained that about 30 years ago, farmers in West Africa found cassava plants in the fields damaged by CMD that looked healthy, indicating they were resistant. Although the trait can be introduced in other cassava cultivars using conventional plant breeding processes, such efforts are usually time consuming and the improved varieties do have undesired traits as well.

“Cassava breeding is a difficult and multi-year effort. Also, because the cassava genome is highly heterozygous, genetic crosses produce offspring with variable phenotypes,” he explained.



Some plants are resistant, but only on the leaf, others only the root. Credit: Henryk Hanokh Czosnek et.

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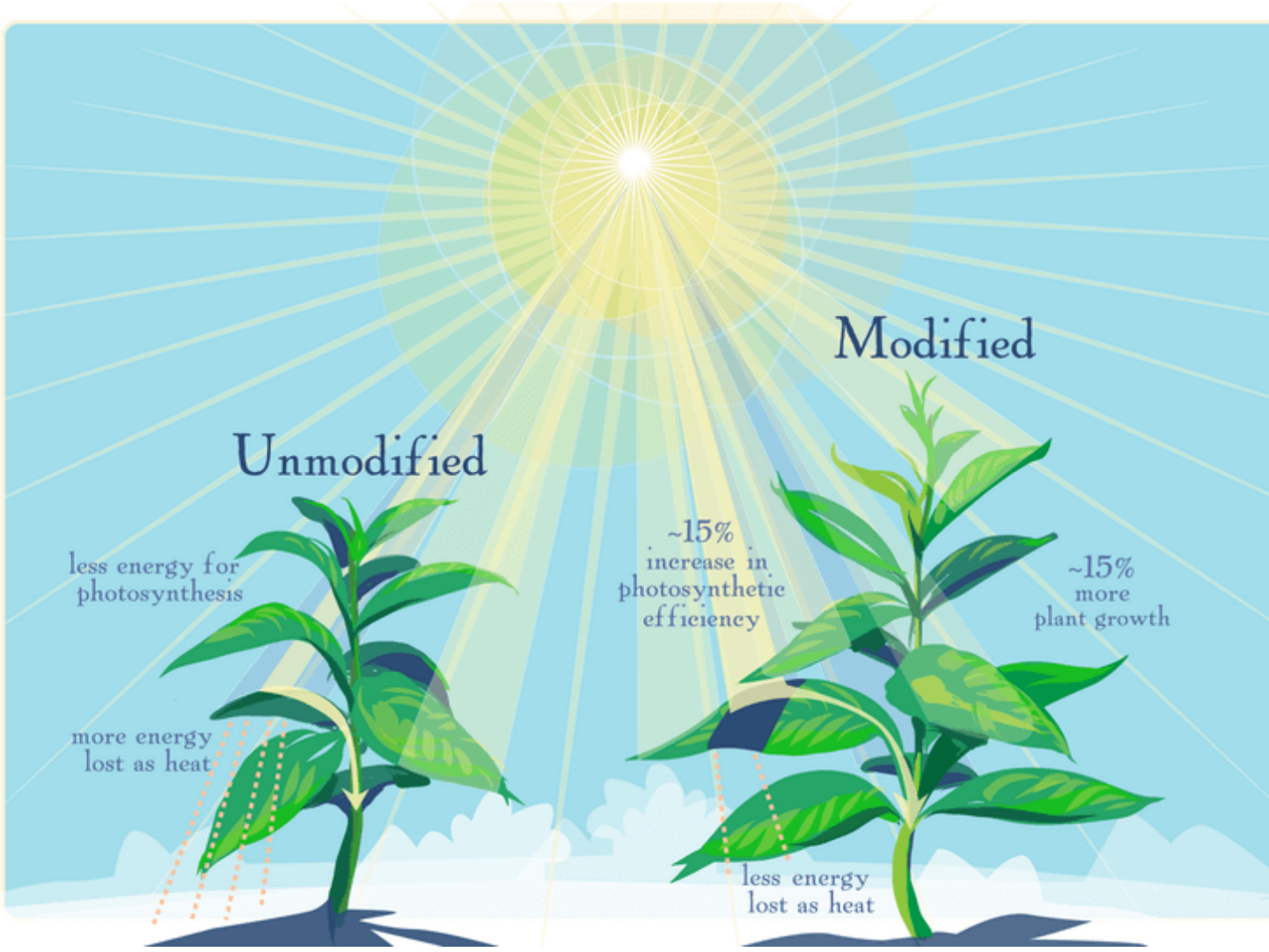
A recent statement from ETH Zurich said “by pinning down the gene responsible for the resistance, the researchers are playing an important part in enhancing food security in tropical and subtropical regions.” Now that the genes have been identified, Gruissem told the Alliance for Science, CRISPR geneome editing methods can be explored to develop resistant varieties. He explained that in 2021, two laboratories first reported a new CRISPR-Cas method called “prime editing” for targeted mutagenesis in human tissue culture cells and rice. This method allows the introduction of specific single mutations in the DNA.

“The method can be used to introduce the mutations we found that provide CMD resistance into susceptible cassava varieties. Work is currently underway to test the CRISPR-Cas prime editing method in cassava for this purpose,” he said. “Thus, the CRISPR-Cas prime editing method can be used to introduce CMD resistance especially into farmer-and consumer-preferred cassava cultivars. This would help to preserve the good qualities of these cultivars and by making them CMD resistant at the same time help farmers to prevent yield and economic losses.”



CRISPR could increase resistance, and yields. Credit: Julie McMahon via University of Illinois

What is cassava mosaic disease?

Cassava is a staple food for nearly one billion people around the world. Smallholder farmers in Africa grow it a lot because it is undemanding crop, does not need fertilizer and grows even in dry areas.

But sap-sucking whiteflies do infect cassava and transmit Geminiviruses, resulting in the cassava mosaic disease, which can destroy entire fields and decimate yields. The disease causes cassava plants to have twisted leaves, resulting in an an overall reduction in both leaf size and the plants. The leaves of the plant turns from green to yellow. It also causes loss of tuber yield as a result of significant storage root yield losses. The disease is a particularly severe problem in Africa and India, and is currently spreading through cassava fields in Southeast Asia, hence the urgent need for CMD-resistant cassava cultivars. The disease is caused by virus, making it very difficult to treat.

Whiteflies infesting cassava. John C. French Sr via Bugwood.org

Dr. Daniel Dzidzienyo, coordinator for the Anglophone Africa Research Program at the West Africa Center for Crop Improvement (WACCI), said CMD is a big food security problem on the African continent that has

to be dealt with. In Ghana, for example, “CMD is very endemic,” he said. “Recent work done by some researchers showed that about 96 percent of farms surveyed in cassava growing areas in the country have CMD with varying severity levels.”

“CMD possess the risk of about 90 percent yield losses in cassava, and the devastating effect of the disease cannot be overlooked. The need for urgent solutions to mitigate the damaging effect of CMD is very crucial for both productivity of the crop and economic purposes,” he observed.

Dzidzienyo said that identification of the resistant gene by Gruissem and his team could have a huge positive impact on efforts to protect cassava from damage and improve food security on the African continent.

“The prominence of the occurrence and severity of CMD in Africa generally, specifically Ghana, greatly affects yield leading to economic losses. This discovery of a gene responsible for resistance against CMD is very crucial for cassava production. especially in Africa, and needs to be explored,” he told the Alliance for Science in an interview.

“It could potentially mean a tremendous boost in the productivity of the crop and improved livelihood of farmers,” Dzidzienyo added.

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