Oranges and Gene Editing:

Innovating to Save the Citrus Industry

For more than 10 years, citrus greening disease has affected Florida's orange industry. A determined group of plant breeders at the University of Florida Citrus Research and Education Center (CREC) in the United States believe new gene editing technologies offer citrus growers a reason to be optimistic.

The Orange Industry Then and Now

Since Spanish explorers brought orange trees to St. Augustine in the early 16th Century, citrus has achieved the status of Florida's signature crop. Growth of Florida's citrus industry closely parallels America's economic rise. Commercial citrus production expanded steadily throughout the 19th and 20th centuries, making a tall, cool glass of Florida OJ for breakfast an iconic staple of the American diet.

By 1950, growers were harvesting more than 100 million boxes of fruit annually. Two decades later, the harvest surpassed 200 million boxes and the 1997-98 season saw an all-time high, 244 million boxes. Florida's orange crop is the reason the United States is one of four countries in the world — Brazil, India, and Mexico are the other three — whose citrus production accounts for about 60 percent of the worldwide output.

But sometime in the early 2000's the arrival of a flying insect would forever alter the story and the success of Florida citrus. Smaller than the head of a pin, the Asian citrus psyllid snacks on citrus trees, depositing bacteria that gradually starves trees of nutrients.

The Disease Threatening Florida's Citrus Industry

First detected in 2005, Citrus Greening disease, also known as Huanglongbing (HLB), has impacted all citrus-producing counties in Florida, leading to a 75 percent decline in the USD$9 billion industry. HLB is present in other citrus-producing regions around the globe including Nepal, where their USD$35 million Mandarin industry is threatened by the same disease.

A tree infected with HLB can live for years without symptoms, allowing the pathogen to spread undetected to other trees. Root systems of infected trees are often poorly developed and new root growth may be suppressed. Early symptoms of yellowing can appear on a single shoot or branch and usually spread throughout the tree over the course of a year causing the productivity to decline. Often, infected trees only produce a small amount of shrunken, flavorless fruit.

According to statistics from the U.S. Department of Agriculture (USDA), Florida orange crop production has decreased by 70 percent in the last 20 years and continues to decline.

Florida Researchers Using Gene Editing to Fight Back

While Citrus Greening is a global threat affecting Brazil, Nepal, and Mexico, among other citrus producing regions, it has wrought particular devastation on Florida's citrus Industry. As the second largest producer of orange juice in the world, citrus is a major economic force, contributing over 70,000 jobs. But lower crop production resulting from the disease represents a real and significant threat both for the state's economy and Florida's ranking as a global citrus producer.

Dr. Fred Gmitter, a professor of Horticultural Sciences at CREC, and his colleagues are conducting genomic research to try and save the state's orange groves. Their goal is to develop efficient ways to enable cloning and manipulation of genes that help citrus trees defend against the bacteria.

As a long-time Florida resident, Dr. Gmitter has witnessed the personal and business-related misfortunes of those working in the citrus industry.

"Many family farms in Florida have gone out of business," Dr. Gmitter says. "There are some packing houses for the fresh fruit industry that have been owned by families for three or four generations that have closed. That way of life has supported close to 80,000 jobs in Florida alone, so it's not just a handful of people who are suffering."

Since the orange genome was sequenced in 2011, scientists have been able to apply their learnings about fruit quality and disease resistance. For example, shortly after the genome was successfully mapped, Dr. Gmitter teamed with Dr. Bill Castle and Dr. Jude Grosser to develop new, potentially disease-resistant citrus varieties. One of them, *LB8-9,* known commercially as Sugar Belle, has proven to be the most disease tolerant variety available to citrus growers.

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DR. FRED GMITTER
PLANT BREEDER & GENETICIST
UNIVERSITY OF FLORIDA CITRUS RESEARCH
AN EDUCATION CENTER

"Because this disease is caused by a bacterium that lives within the plant, not on the plant, there's no way a spray can kill the bacteria," Dr. Gmitter explains. "It's moved by an insect that flies and feeds on the plant, so it spreads fairly rapidly," he adds.

Today, Dr. Gimitter and his team are using CRISPR technology to make precise edits to the genome in efforts to develop a Citrus Greening resistant orange variety.

Because Florida is no longer alone in its battle against Citrus Greening here in the United States—the disease has spread to Texas and California—officials are anxiously watching the research team's developments. Research organizations in affected areas are also joining the fight to accelerate research.

"Citrus Greening is spreading throughout the world," Dr. Gmitter says. "It has moved throughout South America, throughout Central America. It's been in all parts of Asia, specifically China and India. If we don't do something to solve the citrus greening problem, the decline in global production is going to continue."

Innovating to Achieve a Sustainable Future

The CRISPR/Cas9 genome editing methods allow teams of researchers like the one at CREC to develop genetic breakthroughs with the DNA of plants. From new sequencing to better traits, this technology has

significant potential for innovative solutions.

Additionally, gene editing can shorten the time frame of a plant's natural adaptive abilities. There is a chance that over the course of thousands of years, orange trees could develop resistance to Citrus Greening disease. But, by working with gene editing technology, researchers can speed up that process by working within the genetic potential of the plant's DNA.

With global population on the rise, Dr. Gmitter sees gene editing as a powerful tool that can help achieve future food demand.

"Plant breeders typically have very long-term time horizons. We understand just how long it takes to create new plant varieties, have them accepted by the industry and purchased by the consumer," Dr. Gmitter says. "But if we're going to effectively address global demands on agriculture, we need to accelerate the rate of progress."

Dr. Gmitter does not underestimate the scope of the problems we face. He explains that a sustainable food supply chain means increasing yields and productivity, developing disease resistant and drought tolerant varieties and improving nutritional quality. "If we only had the traditional plant breeding techniques of the past at our disposal, our challenges would be far more daunting. But right now, the tools we have at hand are things plant breeders were dreaming about 30 years ago. If I could, I'd work another 30 years just to see how it all unfolds.

Key references:

National Research Council. 2010. Strategic Planning for the Florida Citrus Industry: Addressing Citrus Greening Disease. Washington, DC: The National Academies Press. https://doi.org/10.17226/12880.

Timilsina, K. (2019). Citrus greening: Nepal's groves under threat - The Himalayan Times. [online] The Himalayan Times. Available at: https://thehimalayantimes.com/opinion/citrus-greening-nepals-groves-under-threat/

Pekic, V. (2019). Citrus greening continues unabated in Brazil. [online] IEG Vu. Available at: https://iegvu.agribusinessintelligence.informa.com/CO221605/Citrus-greening-continues-unabated-in-Brazil.

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