How a genetically altered virus could save Florida's decimated orange industry from citrus greening disease

In the early 1970s there was a ubiquitous television ad promoting Florida orange juice including the line, "a day without orange juice is like a day without sunshine." That dark day could be approaching soon, at least in terms of the juices we get from the Sunshine State and the livelihood of the farmers who grow the trees that have long supplied us.

The iconic orange juice industry in Florida is facing an existential threat because of a severe bacterial disease of citrus that was introduced to the US from Asia in 2005 (the Asian Citrus Psyllid insect that helps to spread it was first found in Florida in 1998). A Florida homeowner may have inadvertently introduced the bacterium to the US in citrus budwood he brought home from Asia to graft onto his backyard trees. The malady is often called "Citrus Greening," but in Asia it is known as Hualongbong and so we now tend to call it HLB.

HLB has since spread to virtually all the back yard and commercial citrus trees in Florida, killing many of the trees and forcing the growers to struggle to keep the remaining ones alive with intensive nutrient feeding and other stop-gap measures.

In 2013 journalist Amy Harmon wrote an excellent article for the New York Times about the history of this crisis titled: "The Race To Save The Orange By Altering Its DNA." She described in detail how this long-anticipated threat finally materialized and how the Florida growers funded university research to explore possible solutions including genetic engineering. A biotech solution was identified using some defensive peptides that are naturally made by spinach plants, but as Harmon explained, that sort of "GMO" solution was a hard sell to the big, brand-sensitive juice companies who buy the oranges.

I have been personally disappointed to watch the way that the juice companies have acquiesced to the pressure to use a "non-GMO" label. That unfortunate marketing ploy now appears on all the brands including the one company that relies exclusively on Florida fruit as opposed to a mix with imports. This is a classic case of how "control of the food supply" is really in the hands of anti-technology activist groups, not the big companies most often so accused.

Image: My Windowsill

But realistically, deploying a biotech trait like this in a perennial crop would be quite slow because the growers would have to start over with new trees or possibly graft onto the existing rootstocks and regrow the entire above ground part of the plant. In the mean time, the industry has been steadily declining and the fear is that it will reach a point where it just isn't worth maintaining the juice plants. Orange juice can certainly be imported, but for a time the Florida industry was able to distinguish itself by its better tasting "not-from-concentrate" advantage.

This same destructive disease now threatens the citrus industries in other states. The disease and its

insect vector are already present in California, but for now it has been contained to mostly urban/suburban areas in the southern part of the state. If it spread to something like the tangerine/mandarin groves of the Central Valley and other parts of the $3.4 Billion California citrus industry, that would be a disaster (think Cuties(r), Halos(r), lemons, navel oranges, grapefruit etc.) Once again, the marketers of most California citrus have also caved into the pressure to add the non-GMO label even though there are currently no biotech varieties and even though the technology may someday be the only way to save the industry.

But I'm happy to say that I'm writing about a newer technological approach to deal with this disease. An extended public comment period ran through Tuesday May 30th in which the USDA asked for feedback on the question of whether or not to approve the commercial deployment of a different way to protect orange trees from the HLB disease. It is something which could possibly be implemented much more quickly than by genetically engineering the trees themselves. This is something that could be presented in a way that would make it sound scary, but it's really not.

Image: Steve Savage

There is a virus that infects orange trees called Tristezea. It also came from outside the US and began causing problems in all the citrus growing regions of the US in the 1960s. At first it was also a lethal disease, but eventually it was found that by avoiding certain rootstock types, the virus could infect the trees with no symptoms at all. (Virtually all fruit crops have been grown on rootstocks for centuries). In Florida today all but the youngest trees are infected with Tristeza, but with strains that are benign for trees when they are on the rootstocks now used.

The new biotech solution is to add genetic sequences for the spinach antimicrobial peptides to the RNA of the virus, and then get that virus to infect orange trees. This could be done with new trees when they are in nurseries, but it may be possible to also "graft transmit" the virus into at least the younger trees already out in the commercial groves. In this case that new small branch does not need to take over, it just allows

the virus+peptides to move into the other parts of the existing trees. In any case, modifying the virus is far more efficient than having to separately engineer and propagate each of the popular citrus varieties in the industry.

A small scale trial that was run for several years confirms that this sort of virus inoculation can make the trees resistant to the HLB pest and to allow full productivity. As part of that experiment, trees with no virus were planted all around these test blocks and then followed to see if the engineered virus ever moved into them (the virus can be transmitted by aphids under certain circumstances). In fact the virus didn't move, though even if it did it wouldn't be a big issue. Also, over time the modified virus loses the genes for the spinach peptides which is then another barrier to any sort of unwanted spread. Also it is clear that the Tristezea virus does not have any bad effects on other crops or wild plants since the virus has been very widespread for decades without causing problems in other species.

orange grove

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Image: Grist.

I've included the comments that I submitted to the USDA below concluding with my hope that the experience in Florida will pave the way for using a similar approach in California if we ever have to save that industry as well. I sincerely hope that the USDA does approve this new method and I sincerely hope that those who control the juice plants will both help the growers that supply them and trust consumers to be smart enough to listen to the logic about this technology.

I submitted a public comment (via this link) as an individual scientist and as a citrus consumer:

I am writing in support of this release permit as I believe that it is a very logical strategy with the potential to literally save the citrus industry in Florida. If it proves successful it could play a similar role in the unfortunately likely scenario that HLB becomes a more serious threat to citrus production in other regions such as California.

I am a plant pathologist with a Ph.D. from the University of California, Davis. My own work there was with fungal diseases, but I spent a lot of time in the lab of Dr. Robert Shepherd, a National Academy virologist. Starting at that time in the late 1970s, I had many close colleagues who were working on the early stages of plant genetic engineering, and I have continued to follow that field ever since. The progress of the field has been remarkable.

In preparation for this comment, I read all the available documents from the USDA site and corresponded with some of the university researchers who have done the relevant work on issues like the potential for recombination and transmission of the modified Tristeza virus.

This approach of using an asymptomatic strain of the virus is particularly logical for this perennial crop. To engineer the orange scion itself would require the generation of separate “events” in each of the important cultivars and then a delay to graft those onto existing trees and bring that new “top” into bearing. Using the virus makes it far more feasible to utilize more than one combination of antimicrobial peptides which will help to prevent the development of resistance in the HLB bacterial pathogen population.

There are several convincing reasons that this strategy is likely to be safe with regard to any potential for spread to non-target citrus or to other plant species. There is a very low rate of aphid transmission even under ideal lab conditions. The track record of zero transmission to sentinel plants in the previous limited release further demonstrates that the modified virus is extremely unlikely to move beyond the intended trees.

The fact that recombination will likely lead to loss of the peptide part of the viral genome is another safety factor and will again allow for the deployment of different peptides in a follow-up grafting step if that is needed down the line. The fact that the Tristeza strains to be used are already ubiquitous in Florida citrus represents a multi-decade “experiment” showing that this virus represents no threat to other species or to citrus that is grown on the rootstocks, for which infections by these strains are asymptomatic.

With the tremendous advances in the speed, sensitivity and affordability of genetic assays, it will be possible to rigorously monitor the efficacy and safety of the strategy. As for the anti-microbial peptides from spinach—long experience supports their safety from a food point of view.

I believe that this release can be the culmination of an exemplary example of an effort funded by the grower community and partnering with the public, academic community to employ state-of-the-art science.

I have been working in agricultural technology for 40 years and have been writing and speaking about food and farming since 2009. Opinions expressed here are my own.

This article originally ran at Forbes as Can The Florida Citrus Industry Be Saved? and has been republished here with permission.

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