HLB COVID-19 parallels

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In my previous article, I spoke of the importation of rootstocks from Florida that have shown tolerance to HLB that were due to arrive in early 2020. In that article I explained the need to evaluate these varieties in SA for their commercial potential to select the best candidates as soon as possible, before the arrival of HLB.

Unfortunately, at about the same time that these rootstocks were arriving, it was reported that HLB had now been discovered in three of the nine sites currently being surveyed in Kenya. One site is just north of Tanzania, where the Asian Citrus Psyllid, ACP *(Diaphorina Citri)*, right, had already been reported during the last CRI Symposium.

Asian Citrus Psyllid, ACP (Diaphorina Citri)

The combined presence of the disease with the vector, ACP, poses a significant risk to citrus production. With the spread of COVID-19 (I write this article during the early April lockdown), we have seen governments take action not without a parallel to those required for the coming battle we face with HLB. For the first time in history we have seen governments across the world locking down their countries at massive economic cost due to the rapid spread of this novel virus across the world. And there is currently no vaccine or cure. All options are being weighed up in attempts to mitigate the spread and prevent the probable collapse of health systems in even the most affluent societies. While in the background, scientists work frantically for cures and vaccines, hoping immunity can be reached without too much collateral damage.

Likewise, the citrus world has no curative control treatment for HLB. Originating in China or India more than a 100 years ago, the advent of large scale commercial plantings has seen it spread rapidly through Asia and South and Central America; in recent years through Florida, into Texas and neighbourhoods of Los Angeles and in Africa, into Ethiopia, Madagascar, Reunion and now, on our doorstep in southern Kenya. The HLB Steering Committee and our own industry's Biosecurity Advisory Committee will be similarly looking at all possible mitigation for the spread of the disease. As our government looks to the affluent economies up north for breakthrough in the fight against COVID-19, we will need to look at all options to fight this disease.

With the domestication of plant foods around 8 000 or 9 000 years ago, man started breeding to build resistance or tolerance against agricultural diseases. Many see this strategy as a way to fight the onslaught of the HLB bacterium.

The search for rootstocks resistant to HLB is one of the many options. Luckily, some cultivars that are continuing to look good in Florida are already here, one being SA's own X639, a Cleopatra *X Poncirus* trifoliate bred by Dr. Hojby at the ITSC, in the early 1950s. Three of the "Looking good" rootstocks were imported by CGA CC from USDA in 2015 - they are now cleaned and should give the first seed at the CFB this year. It is good to know that we have a head start while the new arrivals from Florida are made into trees for evaluation by Dr. Paul Cronjé and his team.

It is widely accepted by countries that are already fighting HLB that a multi-system approach is required, like for COVID-19. Unfortunately, hand sanitation and social distancing are not going to hold back this one, described as such by Fred Gmitter for Floridian Farmers: "This has been the worst possible nightmare imaginable. In the last 12 years their production has decreased by 75%, with many third and fourth generation families going out of business." Gmitter is a plant breeder and geneticist at the University of Florida CREC.


Jon Roberts

Tolerant cultivars for these rootstocks are another obvious choice for evaluation in SA. The Citrus Growers' Association Cultivar Company (CGA CC) and Dr Graham Barry have already introduced several cultivars from the Florida breeding programme, where tolerance against HLB has been evaluated for some time.
Several of these cultivars have shown promising results in Florida.

Cultivars most sensitive in Florida:

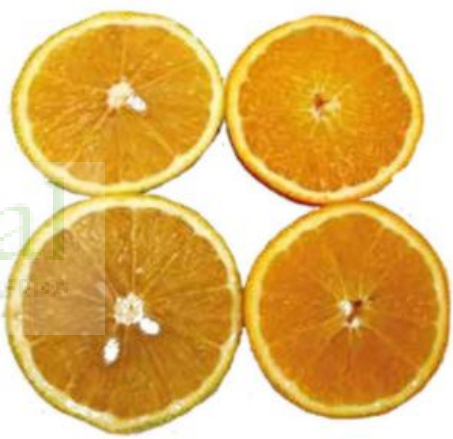
- Sweet Orange
- Grapefruit, Ray Ruby
- Some Mandarin hybrids
- Some pomelos

Less sensitive:

- Mandarin varieties, Nova, Shatangju

Some tolerance:

- Lemon, Persian Lime
- Some pomelos
- Citrus latipes
- Orange-like and Mandarin hybrids such as LB8-9, RBB7-34. This breeding programme is ongoing and several new Sweet Orange-like varities have been added.


Left: Glenn orange; right: RBB 7-34 (orange-like) Orange X Mandarin, showing tolerance to HLB

According to Prof. Fred Gmitter and Jude Grosser, these tolerant cultivars appear to be able to produce a larger amount of replacement phloem in the cambial zone, whereas sensitive types shows phloem destruction and disorganisation. In other words, the tolerance appears to be associated with the ability to produce new plumbing by "putting a new pipe in", as Fred Gmitter describes it. Gmitter and Grosser are studying phloem regeneration in other citrus varieties. If they can "learn how to manage and control this regeneration phenomenon," he says, "it may be one way to fight back against the disease." Acknowledgements Fred Gmitter and Jude Grosser, *The ultimate long term HLB solution.*

But like COVID-19, a tolerant infected "carrier" might appear asymptomatic, but will still be able to infect other trees via the ACP vector. And this is one of the main problems. The disease is inside the plant, not on the plant. Therefore, it can't be sprayed.

So, there should be a combination of approaches:

- Prevention: presently, China has three main areas of their defence strategy.
- Clean nursery trees.
- Remove infected trees.
- Monitor and spray ACP (this is similar to the SA approach with African Greening).
- Brazil has ten measures, including the use of a fungus, *Isaria fumosorosea* that acts as a parasite to the Psyllid.
- California has started the release of a parasitic wasp native to Pakistan, *Tamarixia radiata*, which has been particularly effective. I was fortunate to see the production facility managed by David Morgan.
- RNA interference with CTV, as a drug delivery vehicle with genes to make proteins that attack HLB or carry molecules that are poisonous to the *Diaphorina* psyllid.
- Similarly, scientists at Southern Gardens are currently seeking approval to release an engineered CTV designed to express a peptide, "Defensin" with anti-microbial properties.


Prof Fred Gmitter, holding Sugar Belle fruit

Left: HLB positive tree, in UF CREC trial site

• And a natural antibiotic, Radicinin found in a fungus.

On the plant breeding side, CREC are similarly looking at CRISPR genome editing methods to move beyond tolerance to hopefully full resistance. CRISPR is already being looked at to cure debilitating diseases in humans and animals, and similarly there is the potential to use this technology in plants. According to Fred Gmitter, "by going into the DNA sequence of the plant, it is possible that minor changes can be made in the plant's genes - for instance, that could create a tree that protects itself from the pathogen. These are natural mutations that would most likely happen; given enough time citrus trees would slowly develop this resistance, probably over several 100 000 years. With CRISPR, we are able to do that now."

This work is ongoing and CGA CC will keep watch for the release of any of these new cultivars that may have similar commercial characteristics to our current HLB sensitive, Sweet Orange range.

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