Citrus Brown Rot

by David Whyte

Last year my crop was hit hard by citrus brown rot. Brown patches appeared on the leaves, causing leaf drop – although many of the leaves that dropped would have no brown patches. At times, round soft patches would appear on the fruit, which would quickly go brown. Over time, a very distinct smell appeared, although this took a few weeks to become apparent, which made the brown rot diagnosis difficult as all the information I found about brown rot mentioned the distinctive smell.

I thought it was just me and my orchard management, but many other Waikato people have reported that this year they have had issues with a mystery disease, which is the same brown rot. So it may be that new strain of brown rot has arrived, or that climatic conditions have changed in upper North Island, allowing brown rot to thrive.

Brown rot is caused by a *Phytophthora* infection. Phytophtora are water moulds, which are present in New Zealand soils, and cause root rot/collar rot. This is the reason that New Zealand citrus rootstocks are trifoliate orange (*Citrus trifoliata/ Poncirus trifoliata*), as this is highly resistant to *Phytophthora* infection. This is also why you don't want soil to build up to above the graft union, as the *Phytophthora* can then attack and cause collar rot. Given that grafting is done quite high, this shouldn't be too much of a problem.

It is stated that in New Zealand the infection strain is *Phytophthora citrophthora* and that, "leaf infection shows first as translucent spots, usually towards the tips or along leaf edges. Some leaves rapidly turn brown, curl up, but remain attached to the tree for some time, while many other infected leaves drop within a few days of lesions forming".[i]

However, the infection may be due to other *Phytophthora* species. Overseas there are different *P. citrophthora* strains that have different levels of virility. In Florida, brown rot infections can be caused by *P. palmivora*, or *P. nicotianae.* It has also been found that a number of other *Phytophthora* species may also cause citrus brown rot. So it would seem that *Phytophthora* have a wide range of hosts, and it may or may not be *P. citrophthora* causing the infection. In Florida, when autumn temperatures are 23–32°C, infection with *P. nicotianae* is common, and around the Mediterranean it is autumn temperatures of 18 – 25°C that allow *P. citrophthora* infections to thrive. Yet in late winter, when the brown rot appears to spread the fastest, temperatures are clearly not this high. And in spring, when temperatures are rising, the brown rot seems to loss its virility.

My assumption is that citrus, being warmer climate fruit, would be under cold stress in winter. Also, the rootstock *Citrus trifoliata* is deciduous. So come mid-winter there would be minimal nutrients flowing up to the leaves, so under an immune challenge, the plant cannot respond as it usually could at other times of the year.

In Florida it was found that either the fruit were infected from soil particles splashed up by rain, or by fallen fruit being infected, then setting sporangia (the fruiting bodies of the mould) and this being splashed up by water. Thus solution is either to have plants, mulch or other material that stops soil particles being dislodged and splashed by rain, and to clean up all fallen fruit.

I know that in our orchard, the infection starts around trees that have dropped a large number of fruit. As in New Zealand our rootstock is deciduous, I hypothesis that when the leaf drop occurs in late June, that nutrients stop flowing from the roots to the fruit. Thus the tree drops the fruit it cannot carry to maturity.

Irrespective of temperature, it is the wet conditions that allow for movement and transfer of *Phytophthora* from the soil, or infected fruit, to the tree leaves, and other fruit in the canopy. The sporangia form in wet conditions, and constant moisture for 72 hours causes significant spore formation. The spores can actually move through water, using a tail-like appendage and are thus able to move around to infect the leaves or fruit. When it germinates, the spore can send its hyphae into undamaged leaves and fruit, therefore external damage to the fruit or leaves is not required for infection to occur.

Reducing canopy moisture levels by increasing wind flow and increasing light filtration are recommended as preventive measures. I have noticed the trees that I have pruned heavily to reduce their fruiting height, have reduced rates of infection due to their open canopy structure. Also the trees on the south side of my shelter belt are harder hit, indicating my shelter should be more heavily pruned. In Florida where trees can be so heavily laden the branches bend down and fruit is close to the ground, it is recommended that people prune the bottoms of the tree so that fruit is not close to the ground. But in my observation most citrus trees in New Zealand are already pruned like this (or naturally occur like this?). Early advice (1971) was to prune so all fruit and leaves were three feet (1 m) above the ground. This seems to be at odds with all current management practices of wanting to keep trees short for ease of picking and pruning.

Different citrus varieties are more susceptible than others. At high risk of infection are lemons and New Zealand grapefruit (Poorman's orange). Other sources also list navel oranges as susceptible. This explains why my navels got hit hard, yet my tangelos were barely touched.

The conventional treatment is to spray with Dithane M45 and Captan, a less brutal approach is to use copper (either oxychloride or cupric hydroxide). These are sprayed in autumn for protection, but for sites with a history of infection, spray also in July.

The Chaetomium fungus has been shown to provide biological control of Phytopthora. These fungi eat and consume the *Phytophthora*, however commercial formulations are yet to be developed.

Trichoderma species were trialled as a biocontrol agent in lemons. It was shown to reduce lesions up to approximately 60% depending on the strain of *Trichoderma* used. Very good control was achieved by utilising two *Trichoderma* species against *P. parasitica*, which is the dominant brown rot pathogen present in India.

There could be some useful biocontrol effects from *Trichoderma*, but whether the species available in New Zealand have any effect has not been studied. Rather ironically, *Trichoderma viride* causes post-harvest infection of citrus when the fruit is injured; causing a leathery brown discolouration so not all *Trichoderma* species are beneficial.

So encouraging a healthy microflora of various fungi may help reduce the incidence of citrus brown rot in my orchard.

iAtkinson J. (1971) Diseases of Tree Fruits in New Zealand. Downloaded for free from https://www.hathitrust.org/

References

Growing Citrus in New Zealand, HortResearch, edited by Pauline Mooney
https://www.ncbi.nlm.nih.gov/pubmed/26539045
https://link.springer.com/chapter/10.1007%2F978-1-4757-9468-7_25#page-1
http://www.thebioscan.in/Journals_PDF/7415%20R.%20M.%20GADE.pdf