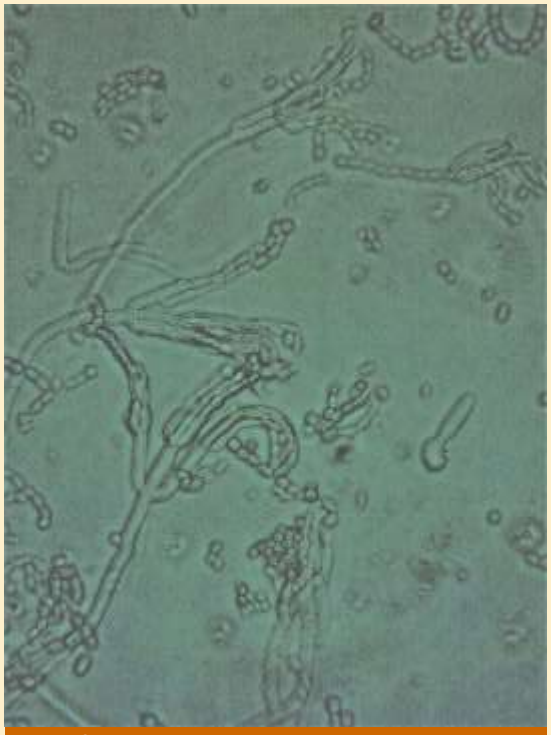
What hides in the woodwork?

Fungi not only wreak havoc with fruit quality and shelf life; they also eat away at the wooden pallets on which cartons of fruit are transported. A recent study, however, has uncovered several solutions.



The fungus *Penicillium* as seen under a microscope

Every day, between 1.9 and two billion pallet bases are used for various purposes around the world, including the transportation of fresh fruit. In 2020, South African fresh fruit exports used about 3.5 million pallet bases, with citrus exports accounting for about two million. The rest was used to deliver pome fruit, table grapes and stone fruit to international consumers.

Fungal contamination on a pine pallet

Pallet bases are mostly made of pine and are susceptible to degradation. The situation is particularly worrisome in terms of South Africa's distant markets, such as the Far East and Canada. About 21% of export citrus find their way to markets in these far-off regions. Given the long periods the fruit spend in transit, there is enough time for fungal contamination to develop on the pine slats and corner blocks of pallet bases. In severe cases, incidental fungal growth develops on the cartons at the bottom of

the stacks. This not only soils the packaging, but also weakens both the wood and cardboard structure. Apart from unacceptable aesthetics, these incidences pose a phytosanitary risk.

In the past, the fumigant and pesticide methyl bromide (MeBr) was used to keep wood-attacking fungi at bay. However, due to its toxicity and damaging impact on the ozone layer, and danger to humans and animals when used incorrectly, the use of MeBr was banned.

Its replacement, 2-ortho-phenyl-phenol (OPP), has proven disappointing. Apart from not being particularly effective against fungicides on pallet wood, OPP muddies the allowable-residues waters. Residues of the chemical have been detected in Europe on fruit that had been declared either chem-free or organically produced. Although the OPP were discovered at levels close to the limit of detection (LOD = 0,01 ppm), any organically produced or chem-free fruit should have zero residues. Furthermore, while OPP residues may be allowed on conventionally produced fruit, it adds another chemical residue to an already very limited number of residues that are allowed by some retailers.

Given that OPP poses an unnecessary risk and that fungal degradation outbreaks on wooden pallet bases have been on the increase since the banning of MeBr, alternative actives are urgently needed. The matter is further complicated by the fact that the source of fungal contamination on pallets is unknown, which makes it difficult to treat.

Between late 2018 and early 2020, Dr Wilma du Plooy from Citrus Research International (CRI) led a study to find a solution to fungal contamination of pallet bases. Although her study was focused on the citrus industry at the outset, similar challenges in other fresh fruit sectors resulted in cooperation from the pome and stone fruit, and table grape industries.

THE PROJECT'S ECONOMICAL IMPACT

The volume of fruit exported by the South African citrus industry used 1 841 243 pallet bases in 2020, while the export volumes for pome fruit (1 178 000 MT), table grapes (305 000 MT) and stone fruit (67 566 MT), required approximately 1,5 million pallet bases. Importation of fresh fruit and vegetables stacked on pallets with mould is an increasingly threatening issue, and exporters are faced with claims, refusals and diversion of consignments. All of these result in huge financial losses.

In 2020, the total turnover for pome and stone fruit was R14,06 billion, with apples earning R7,92 billion, and pears R 3,56 billion and all stone fruit R2,58 billion. Exports accounted for 43% of the produced volume of pome and stone fruit. While no figures are available to indicate current damages due to pallet mould, it stands to reason that the citrus, pome and stone fruit industries can suffer serious losses and therefore job opportunities if the pallet issue is not resolved.

Working with Dr Du Plooy on this study that received funding from the Postharvest Innovation Programme, were Bernard Henning from the Perishable Products Export Control Board (PPECB) and Elaine Basson, also from CRI.

Treated pine wood corner were treated by keeping it completely submerged in the test treatment for five minutes each. The blocks were tied equidistantly to previously infected wood, and placed into a clear plastic bag with 250 ml water to incubate at an air temperature of 34°C.

Project objectives and methodology

In designing the study, Dr Du Plooy knew that the problem needed to be defined properly before solutions could be investigated. One of the main questions to answer, was what the source of the fungal contamination was.

Six objectives were set, divided into two research phases.

Phase 1

1. Determine the occurrence and spread of the problem, including industries other than citrus.
2. Optimise a self-inoculation technique of wood used for pallet base manufacturing.

Phase 2

3. Optimise methods to isolate fungi from collected wood samples.
4. Identify the fungal specimens isolated from wood pallets.
5. Investigate SOPP, as well as alternative products not currently in use for pallet preservation.
6. Determine the extent to which storage practices contribute to the occurrence of fungal contamination on palletising wood.

To determine the extent of the problem, the study team visited pallet manufacturers, and liaised with fruit exporters and fresh fruit industries other than citrus, both in person and through questionnaires.

Phase 1 also entailed simulating fungal growth on wood used in the manufacturing of export pallet bases.

In the second phase, once fungi had been successfully isolated from the wood samples collected at the pallet manufacturers, PCR and ITS sequence comparison in GenBank was carried out to confirm the identities of the isolates. A method to culture wood mould in a controlled environment was developed – a critical step that allowed researchers to test the efficacy of different pallet preservation products.

Questionnaires were sent to citrus packhouses to determine the impact of storage conditions on the development of fungal contamination on pallet bases. The focus was on quantifying moisture build-up and the extent to which pallets are exposed to free water in containers.

Key results

The questionnaires revealed that storage conditions in the packhouses have no influence on the development of mould on the wood. Instead, the pallets themselves, built from wet-off-saw wood, were the source of the contamination.

The researchers found that the problem is widespread in other fruit industries as well, and that recent changes in export conditions contributed to the seriousness of the issue.

In terms of solutions, it was found that while pallets built from pine presented with the problem, eucalyptus wood was not affected by mould. While using a different wood source might appear to be the solution, the availability of pine for pallet manufacturing far exceeds that of eucalyptus. Finding a suitable wood treatment is, therefore, the only feasible option,

As far as treating pine pallets is concerned, three products returned successful results in the controlled testing environment. A product based on stabilised glutaraldehyde is a particularly promising prospect, as it not only controls fungal growth but has a sealing action too.

PROJECT INFORMATION
Project title: Fungal degradation of wood pallets used in export of citrus fruit
Principal investigator: Dr Wilma du Plooy
Duration: 01/02/2019 - 31/03/2021
PHI Programme and Industry Contributions: R275,881.66 & R254,901.50
Lead institution: Citrus Research International
Beneficiary: The South African citrus industry
Human resource development: 1 PhD student, 3 MSc students and 1 technical assistant
Focus area: Pallets, export

Coronavirus travel and movement restrictions made it difficult to obtain the base materials used for the active ingredients in the tested products. Despite this, two of the products are already fully commercialised, with actives that are food grade and have food safety acceptance.

A grading system from 0 – 3 was used in the visual assessment of the efficacy of the products tested, with 0 being effective and 3 denoting no effect in fungal control.

The pine block on the left has been treated with one of the products and shows no visual fungal contamination compared to the untreated pine block on the right.

The issue of OPP residues was addressed in parallel to the fungal contamination study. Following a meeting of several stakeholders, the PPECB became closely involved and a plan of

action was put in place to investigate the products currently used for container hygiene and pallet wood treatment. All affected industries have since implemented management policies and guidelines to deal with the issue.

The successful outcomes of the research study and the cooperation between the citrus, pome and stone fruit, as well as table grape industries, have resulted in significant benefits. It is reasonable to assume that the gains will extend to all fresh fruit and vegetable industries in South Africa. 🧡