Why, and where, good grapes go bad

The well-known management dictum that what gets measured gets managed, is the principle at play in a study that seeks to answer critical post-harvest questions in the table grape industry.

POST-HARVEST FRUIT DECAY caused by post-harvest pathogens results in considerable economic losses. Long distribution chains are particularly vulnerable because, as fruit ripens and ages, it becomes more susceptible to decay.

Although this vulnerability is known, neither the source of inoculum in extended supply chains, nor the actual losses in the distribution chain and the pathogens involved, is fully understood.

One of the more perishable fresh fruit categories is table grapes. In extended supply chains, their demise is mostly caused by the *B. cinerea* and *Penicillium* spp. pathogens.

Despite more than 30 *Penicillium* spp. having been isolated on grapes, existing literature fails to specifically identify the ones that are pathogenic to table grapes. This lack of knowledge results in guesswork when it comes to identifying pathogens in the supply chain.

Furthermore, no evidence or traceability exists to indicate the link between pathogen profiles and losses, and what the ultimate cost to the grower is. The result is the absence of a holistic loss reduction strategy.

According to Professor Lise Korsten, senior lecturer in the Department of Plant and Soil Sciences at the University of Pretoria, the only way to address this issue is to take an all-inclusive supply chain view. "If we don't understand the causal agents involved and their impact on post-harvest decay, we cannot effectively and efficiently apply control measures," she says.

Determined to give the table grape industry a handle on the situation, Lise designed a research study financed by the PHI Programme and industry. Initially planned to run from November 2014 until the end of 2016, her project was extended to December 2017 (see sidebar on page 150).

1 Prof. Lise Korsten, project leader.
2 The spores of phytopathogens, such as *Botrytis cinerea*, can be present in buds at the beginning of the season, but will only develop post-harvest when conditions are favourable.
3 The table grape project team members are (from left) Tarryn Wettergreen, Nazareth Siyoum, Prof. Lise Korsten and Patricia Carmichael.

Project aim and objectives

The ultimate aim of the project is to identify and study the post-harvest pathogens that cause rot on table grapes as they move through local and export chains, so that more effective end-market disease control approaches can be developed.

Project objectives were formulated around three project facets.

Facet 1

- Determine the reason for decay in the local table grape supply chain by linking pathogens with losses, and quantify the economic impact.
- Determine the reason for losses in the export chain from South Africa to the United Kingdom by pinpointing causal agents throughout the chain, and establish the economic impact.

Facet 2

- Develop a novel, accurate and rapid method to identify pathogens.
- Determine pathogenicity and aggressiveness of *B. cinerea* and known and suspected pathogenic *Penicillium* spp. over a table grape cultivar range.

DID YOU KNOW?

Post-harvest pathogens contribute greatly to global food losses that amount to 1,3 billion tonnes per year (FAO, 2011). *Botrytis cinerea* alone is reported to account for 20% of post-harvest losses worldwide, which is valued at between 10 and 100 billion Euros per year.

- Compare the South African and UK distribution chains to get an overview of causal agents and the extent of post-harvest losses in the export chain.

Facet 3

- Conduct a detailed economic analysis of selected table grape value chains to quantify post-harvest economic losses.

Methodology and results

Facet 1

Local and export fruit were sampled on two farms in the Hex River Valley and two farms in the Groblersdal area. Samples of symptomatic grapes, as well as the air around them, were taken at the Tshwane, Johannesburg and Epping fresh produce markets.

Preliminary results showed that *Penicillium* species, notably *P. expansum*, *P. digitatum* and *P. crustosum*, are highly prevalent throughout the table grape supply chain, especially in the local fresh produce market receiving areas, and the repack and distribution areas.

Symptomatic table grapes contribute to poor air quality that, in turn, causes an inoculum build-up that can cross-contaminate other fresh commodities close to the stored decaying fruit. Air quality at the UK re-pack and distribution areas was of particular concern as the total colony forming units were significantly higher than elsewhere in the export chain.

Where table grapes are repacked and packaging is opened, airborne pathogens can cause infection if the berries have micro wounds. Poor air quality and inoculum build-up can be the source of infection in the different facilities within the table grape export chain.

A preliminary conclusion, therefore, is that air quality monitoring and inoculum reduction are of the utmost importance to ensure fresh and healthy table grapes.

DID YOU KNOW?

Approximately one-third of all fresh fruits and vegetables are lost before they reach consumers.

Facet 2

PhD student Pat Carmichael sampled

PROJECT TITLE
Table grape loss reduction technology

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DURATION
Three years (11/2014 to 12/2017)

PHI PROGRAMME & INDUSTRY CONTRIBUTIONS
R1 369 960 & R484 660

LEAD INSTITUTION
University of Pretoria (Department of Microbiology and Plant Pathology)

BENEFICIARY
The table grape industry

FOCUS AREA
Post-harvest disease control

HUMAN CAPITAL DEVELOPMENT
One Post Doc student, one PhD student, two MSc students and one Hons student

PRESENTATIONS AND PAPERS DELIVERED
Five

PUBLICATIONS
Seven

By knowing which pathogens are present in every link of the table grape export supply chain, from the vineyard, packhouse (**1**), cold room (**2**), reefer container and finally where the fruit is the consumer's shopping basket, make it possible to link pathogens with losses.

3 Nadia Botha does air sampling while Patricia Carmichael and Nazareth Siyoum are ready to lend a helping hand.

grapes on three farms in the Hex River Valley and three farms in the Groblersdal area over two seasons. Using both cultural and molecular techniques, the samples were investigated for prevalence and concentration of *B. cinerea*.

Pathogenicity and aggressiveness of the dominant *Penicillium* species were determined by inoculating different table grape cultivars with the presumed *Penicillium* pathogen and dominant isolates. Disease incidence and lesion diameters were recorded to calculate disease intensity.

Results showed that pre-harvest environments contributed significantly to the prevalence and concentration of *B. cinerea* in the supply chain. The study concluded that new-generation technology made it possibly to more accurately detect *B. cinerea* at critical phases of infection during berry development. This provided a more targeted control opportunity, based on the level of inoculum at the different berry development stages, resulting in reduced post-harvest losses.

Facet 3

On the economic part of the project, MSc Agric Economics student, Lianda Louw, collected primary data via electronic questionnaires and telephone interviews with relevant stakeholders. Secondary data was collected through collaboration with various supply chain stakeholders.

Preliminary results, based on the analysis of both sets of data, indicated that significant losses and waste occur before produce leave South Africa. Importantly, losses and waste appeared to not be measured throughout the chain, hence making it almost impossible for role players to implement strategies to mitigate the negative impact on return on investment.

PROJECT EXTENSION

An initial delay in approving the project caused the research team to miss the 2014/2015 table grape export season.

Fruit collection in the local market started as planned but the delay in following the export chain caused a knock-on effect in terms of pathogen isolation and identification, and data analysis.

The team was therefore granted an extension in order to follow the export cycle in the 2016/2017 season so that the statistical requirement of the repeat of trials could be met.

THE POSSIBLE ROLE OF POOR COLD CHAIN MANAGEMENT OR CROSS-CONTAMINATION IN TABLE GRAPE DECAY

Table grapes are highly perishable. Their market life is a function of time and temperature, with the degree of deterioration linked to the length of exposure to higher temperatures, and handling practices.

Recently a simulated table grape supply chain revealed what really happens during the post-harvest life of grapes. It gave the industry much to consider with regards to market chain logistics and management.

In her study, Patricia Carmichael stored table grapes for four, six and eight weeks at cold-storage temperatures, and later exposed them to ambient temperature for four and seven days, respectively.

The aim was to determine the keeping quality at the end of the chain, and further assess the incidence of post-harvest pathogens under simulated conditions.

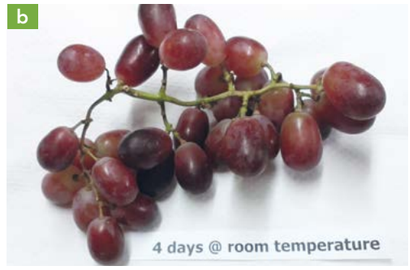
Preliminary results showed symptoms of mainly *Botrytis* at the end of the study period. Prior to exposure to ambient temperature, less than 5% of the stored grapes showed *Botrytis* symptoms eight weeks after cold-storage.

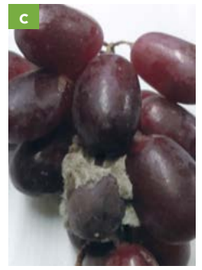
Contrary to the prevalence of post-harvest pathogens observed along the local and export chains, a very low prevalence of *Penicillum* (<2%) was observed in the simulated chain.

However, given the effect of seasonal differences, the study will be repeated in 2017 to reach a conclusive statement.

"Reducing food losses and waste is a priority in achieving a sustainable food future with efficient food systems."

Lianda Louw





The physical appearance of table grapes after six weeks in cold-storage (**a**) followed by four (**b**) and seven days (**c**) at ambient temperature. *Botrytis* symptoms (**c**) were evident on bunches after seven days of shelf life.

d Berries of table grapes inoculated with *Botrytis* isolates to test for pathogenicity.
e *Botrytis* symptom expression nine days after inoculation at ambient temperature.
f Wet season reveals early *Botrytis* symptoms at pre-harvest in one of the farms sampled.