Principles and practices of decay control

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HORTGRO
Growing Fruit IQ

Contents

Scope 3

Principles 4

When and where are fruit infected? 4
In the orchard 4
During and after harvest 4

Risk factors for decay 4
Maturity 4
Injuries 4
Temperature 4
Moisture 5
Inoculum 5

Practices 6

In the orchard 6
All year round 6
During harvest 6
Chemical control 7

In the pack house 8
Cleaning, sanitising, disinfecting, and sterilising: what's the difference? 8
When, what, and how often to clean and sanitise 8
How to clean and sanitise 9
Notes on products 12

Workers 13

Close the loop: environmental monitoring 13

Primary sources 14

Additional resources 14

Scope

This document focuses on postharvest decay and uses the term decay to cover all postharvest rots and moulds caused by fungal infections.

Most food-borne diseases of concern to pack houses are bacterial, while most decay is fungal. Fungi are generally more resilient than food-borne bacteria. Practices that target decay tend to prevent food-borne diseases, but practices that target food-borne diseases may have limited impact on decay.

Chemicals: a caveat

Any chemical that comes into contact with fruit must be approved for use with food and not leave unacceptable residues. Check product documentation (note that following the label is a legal requirement for registered products) and consult your markets before using any chemicals before or during harvest and in the pack house.

Note that maximum residue levels differ by country and some clients' limits may be stricter than the legislated levels.

Chemicals can also cause phytotoxicity. This often depends on concentration and cultivar and may be influenced by the application method. Therefore, test any new products or protocols (such as changes in concentration or contact time) on fruit samples before large-scale adoption.

We value your feedback!

Do you disagree with anything in this document? Or is there something missing? Please send your suggestions to packhouses@hortgro.co.za. We plan to update these guidelines annually.

Principles

When and where are fruit infected?

In the orchard

Infections by *Alternaria alternata* (dry core rot and mouldy core in apples), *Botrytis cinerea* (calyx-end rot in pears and grey mould in general), and *Monilinia laxa* (brown rot in stone fruit) occur as early as flowering but often remain latent until after harvest.

Damaged fruit are at risk from several fungi throughout the season but more so as they mature. Some fungi can also infect undamaged fruit. *Phlyctema (Neofabraea) vagabunda* (bullseye rot of apples) enters through lenticels, but decay usually appears after 3–5 months in storage.

During and after harvest

Penicillium species and *Mucor piriformis* (wet-core rot of apples) are wound pathogens. Infections are usually associated with poor handling and sanitation after harvest. Wet-core rot can also occur preharvest.

Botrytis cinerea, *Monilinia laxa*, and *Rhizopus stolonifer* can cause nest rot by spreading rapidly between neighbouring fruit during storage or shipping. Cold-chain breaks often precipitate nest rot.

Read more about decay pathogens in Fresh Quarterly issue 15: Postharvest disease.

Risk factors for decay

Maturity

Fruit becomes a better medium for fungal growth as it matures. Softer fruit is also more susceptible to injuries that facilitate infections.

Injuries

Injuries promote postharvest infections. Injured fruit also accelerate ripening in surrounding fruit by increasing ethylene production.

Temperature

Low temperatures suppress decay by delaying ripening and slowing fungal growth. Fruit naturally resist decay organisms better at lower temperatures (minus 0.5 °C for most deciduous fruit).

Moisture

Fungal spores need moisture to germinate and infect. High relative humidity or wetting from irrigation or rainfall increase the risk of preharvest infection and postharvest decay. The absolute amount of irrigation or rainfall matters less than the duration of wetness. Prolonged wetting can also increase infection risk by causing fruit to swell and develop microcracks.

Free moisture after harvest contributes to decay risk. Therefore, never pack wet fruit, avoid exposing cold fruit to warm air (may result in condensation), and avoid cold-chain breaks (ditto).

While packaging slows moisture loss from fruit, it also creates humid conditions favourable to fungal germination and growth. Therefore, packaging choice must balance a cultivar's susceptibility to decay with its tendency to moisture loss and shrivel.

Consider packing and palletising within a cold room, even for pome fruit. This limits condensation inside packaging that can otherwise form when cold fruit are handled in relatively warm rooms before cooling.

Inoculum

Inoculum in the context of postharvest decay refers to fungal spores that can infect fruit. The more spores in a fruit's environment, the greater the chance it will become infected and develop decay.

The five components of integrated decay management

1. Reduce the inoculum.
2. Don't damage fruit during handling.
3. Match the packaging to the cultivar.
4. Maintain the cold chain.
5. Apply chemical control.

Practices

In the orchard

Orchard sanitation reduces total spore numbers. Fewer spores mean fewer flower and fruit infections throughout the season as well as fewer spores on fruit entering the pack house.

All year round

1. Decaying fruit are a breeding ground for decay-causing fungi. Starting at thinning, always remove any fallen or damaged fruit from the orchard. Always remove mummified fruit (these can also harbour pests such as developing fruit flies).

2. Remove all remaining fruit from the trees and the floor immediately after harvest. Remember that spores generated from decaying fruit in an orchard of an early cultivar put later cultivars at risk.

3. Do not dump waste fruit where it can become a continuous spore-multiplier. Leaving fruit uncovered in an open pit for later burial does not reduce this risk. Either cover the fruit daily or remove it from the farm entirely.

4. Many of the fungi that cause postharvest decay can proliferate on dead plant material (such as prunings and mowings) and organic amendments (such as compost and manure — incompletely composted manure may also contain bacteria that pose a risk to human health).

5. Avoid introducing soil amendments such as compost and mulch during high-risk periods such as flowering or harvest. Do not leave prunings or broken leaves in the orchard close to harvest.

6. Cover crops and weeds that flower together with the trees may increase the risk of botrytis infections. However, flowering cover crops may also attract and support pollinators, so growers must weigh the benefits and risks for each block.

7. Do not allow a mass of decaying cover crops and weeds to accumulate on the orchard floor during the season. Keep vegetation reasonably short, but avoid mowing close to harvest, as it kicks up spores and particles that land on fruit.

8. Impose speed limits on the farm for all vehicles so that they kick up less spore-containing dust.

During harvest

1. Certifications such as GlobalG.A.P. require that growers and pack houses manage the risk of food-borne diseases. Many of these mitigation measures will also help to prevent postharvest decay by reducing the fruit's exposure to spores.

2. Pickers must never put damaged or diseased fruit in their bags or buckets. Place damaged and diseased fruit in dedicated containers and dispose of this fruit daily. Do not dump waste fruit in the open (see above) and do not send it to the pack house.

Pay close attention to weevil (kalander) damage, stem-bowl cracking (especially in Gala strains), calyx cracking (Cripps Pink and related strains), and picking injuries such as spur punctures in cultivars with prominent spur structures, especially when combined with short stems (for example, Braeburn).

In high-value cultivars with rigid stems, stem clipping can be considered to reduce stem punctures, but be careful not to cause clipper damage.

3. Keep harvest equipment clean. Wash picking bags and buckets at least weekly and whenever moving between cultivars. Wash and disinfect blankets or other materials used to cover bins before each use.

4. Harvest bins must be washed with a disinfectant solution at the pack house each time before going to the orchard.

5. Bin-on-the-ground systems can transfer orchard soil to flume water. Wash dirt off the bins before they contact flume water, but do not spray dirt onto the fruit when doing this.

6. Damping down dusty roads can help prevent dust-borne spores from contaminating fruit.

7. Keep bin-accumulation and -loading areas clean and free of fallen fruit and other organic detritus. Hosing down concrete surfaces at the end of each workday can remove organic matter and reduce fungal spores, but it must not create adjacent muddy areas.

8. Do not harvest wet fruit. As discussed above, wet fruit are at greater risk of postharvest decay, and turgid fruit are more susceptible to handling damage.

9. If rain continues for more than 10 hours, postpone picking until the next day.

Chemical control

1. Formulate a preharvest control strategy in consultation with your crop-protection adviser and marketer. Keep in mind that different markets permit different chemicals and residues.

2. Reduce the development of resistance by alternating products with different modes of action (more information on the FRAC website). Do not use the same fungicides preharvest in the orchard and postharvest in the pack house.

3. Besides applying the right active at the right time, effective control requires sufficient spray coverage, which in turn requires correct application, including spray-machine calibration and operation.

Cleaning, sanitising, disinfecting, and sterilising: what's the difference?

Cleaning removes visible dirt through physical processes such as washing and scrubbing. It can be highly effective at reducing microbes, even though it doesn't kill them. Cleaning products include soaps and detergents.

Sanitising and disinfection aim to kill microbes. Sanitisers are gentler than disinfectants and usually target bacteria rather than fungi. Disinfection aims to kill all microbes, although it doesn't consistently achieve 100% elimination.

Sanitisers and disinfectants can have fungicidal properties, but the term fungicide usually refers to compounds that specifically kill fungi.

Sterilisation destroys all microbes. It often relies on physical processes such as heat or irradiation. Sterilisation is commonly used in medicine and some types of food processing, such as canning. It's not applicable to pack houses.

(Find a fuller discussion in this article or video.)

When, what, and how often to clean and sanitise

Deep-clean and sanitise the pack house in the off-season. This should cover all packing facilities, pack-line equipment (requires dismantling the pack line), cold stores, floors, drains, bins, and packaging storage areas. Don't neglect peripheral areas such as staff facilities.

The off-season is also the time to clean and service air-conditioners and all cooling and ventilation systems (not only those in cold stores). In facilities that operate year-round, the maintenance schedule should allow for annual cleaning and servicing of all equipment and areas.

In season, routinely clean and sanitise the pack house. Clean and sanitise the pack line (particularly tables, conveyors, sizer cups, and transfer brushes), surrounding areas (including floors and drains), and high-activity areas at least once daily.

Empty, clean, and sanitise waste containers (including for rejected fruit) at least once daily. Remove any fruit, leaves, or stems from the pack line and its surrounds at least once daily. Fungi love to proliferate on this material — do not dump any of it near the pack house.

Clean and sanitise bins before reuse for harvesting or storage, especially when re-binning fruit before storage. Likewise, wash and sanitise bins from processing facilities before allowing them into the pack house, as they may harbour spores of fungicide-resistant decay organisms.

Keep packaging materials sealed until needed (uncovered pack material is also a BRCGS violation). Fold cartons shortly before needed.

How to clean and sanitise

Surfaces

Many commercial products combine soaps or detergents with sanitisers or disinfectants. However, organic material inactivates most sanitisers and disinfectants. Therefore, single-step cleaning and sanitising of dirty surfaces is unlikely to be effective. Dirty sanitiser and disinfectant solutions are likewise ineffective.

Instead, remove visible dirt first. As fruit residues are usually the most common dirt on pack-house surfaces, a neutral detergent should suffice. Warm water and high pressure help to dislodge stubborn dirt, especially from hard-to-reach places.

Rinse thoroughly, and apply sanitiser or disinfectant as a mist, spray or foam. Alternatively, use steam-cleaning or high-pressure hot water (above 80 °C). High-pressure hot water is also recommended for cleaning porous surfaces such as wooden bins.

Cleaning often involves a bucket and rag, brush, or mop. If not maintained, these tools can spread microbes throughout the pack house. Refresh cleaning and disinfectant solutions frequently, and wash and sanitise or disinfect the buckets, rags, brushes, and mops themselves after use.

During shifts, wipe high-risk areas and then spray them with a sanitiser. This will help reduce microbes, but it isn't a substitute for daily cleaning.

Effective sanitation and disinfection require the correct product concentration and contact time. The shorter a microbe's exposure, the greater its chance of survival. Consult the manufacturer's guidelines for details.

Water

Use drinking-quality (potable) water for all pack-house operations. Keep in mind that the water's chemical characteristics (such as pH and hardness) affect how it interacts with cleaners, sanitisers, and disinfectants. Ask suppliers which products suit your situation.

Microbes can build up in recirculated water (such as in drenches or flumes), especially if the water accumulates organic matter. Chlorine, which is commonly used to disinfect flumes, is particularly susceptible to deactivation by organic matter.

Pre-washing fruit to remove dirt helps maintain water cleanliness during subsequent processes. Recirculating water systems must include steps to reduce organic loads (for example, filtration) and maintain effective concentrations of disinfectants such as chlorine. Replace visibly dirty water.

Monitor water quality, disinfectant concentrations, and microbial levels at appropriate intervals. For example, if the pack house has a stable water source, annual chemical water analysis is probably adequate, but check pH and chlorine concentrations daily.

Recommendations for water chlorination

These recommendations are based on the concentrations and contact times required to control fungi. They may not be safe or suitable for all fruit types and cultivars.

- pH 6.5–7.5.
- Free chlorine concentration: 25–50 ppm in flumes and 75–100 ppm for drenching and re-binning.
- Contact time: 1–2 minutes in flumes and 30–45 seconds for drenching and re-binning. Shorter contact times apply to higher concentrations.

Cold rooms

Cooling systems can be ideal breeding grounds for fungal spores that can spread throughout a cold room. Therefore, clean all cooling system components, including inlets, filters, fan blades, drip trays, tubes, condenser coils, and evaporator coils, during the off-season. This also improves system efficiency and reliability.

Deep-clean the inside of cold rooms before use, using the same principles described above for surfaces. High-pressure water is highly effective. Warm water is preferable, but keep in mind that water hotter than 50 °C can damage some cold-room panels.

Panels may also be sensitive to steam-cleaning or particular chemicals — consult your cold-room supplier about appropriate products and contact times.

Start cleaning the ceiling and work down to the floor. Do not use abrasive materials that can damage the panels. Do not direct high-pressure water into joints. Allow the room to dry completely before restarting.

Cold rooms can be sanitised or disinfected by manually applying a solution to ceilings, walls, and floors. Alternatively, a sanitiser or disinfectant can be dispersed as a fog or spray. Fogging can achieve excellent coverage but requires safeguards to protect operators.

Some sanitisers may not be suitable given your target market. In some cases, sanitisers have contaminated fruit surfaces, resulting in unacceptable residues.

Check all door seals and panels for cracks and leaks, as these are prime areas for fungal colonisation.

Other than removing fruit or debris from the floor, there isn’t much cleaning that can be done while a cold room is occupied. Do not allow fruit residues and dirt to freeze onto the floor. Prevent free moisture, such as condensation on fruit, as this promotes fungal infection and growth.

Notes on products

Pack houses need to consult food-safety and other relevant specialists when selecting and using cleaners, sanitisers, disinfectants, and fungicides. All products must be approved for use with food and accepted by the fruit's intended market.

Use products according to the supplier's guidelines or the label. Keep in mind that some products are incompatible (for example, quaternary ammonium compounds and anionic detergents inactivate each other). Additionally, some products are unsuitable for cleaning some materials (for example, chlorine corrodes metal).

If controlling fungi is a priority, choose products with demonstrated spore-killing effects. Microbes can develop resistance to sanitisers, disinfectants, and antimicrobials (such as fungicides), so it is recommended to alternate products with different active ingredients.

This document doesn't cover the selection, application, and monitoring of postharvest fungicides. However, research has shown that poor application technique is common, at least in stone fruit. This work is summarised elsewhere.

Workers

Orchard and pack-house workers must be trained in basic personal hygiene, handwashing, and sanitary, careful fruit handling. Damaged fruit is highly likely to develop decay, so preventing damage is crucial.

Overalls, aprons, gloves, and any other external clothing must be washed or disinfected (depending on the material) frequently.

Workers should preferably wear gloves. If they handle fruit with bare hands, their hands must be clean and their nails short. They should not wear jewellery that can damage fruit.

Workers must have access to clean, well-maintained and equipped facilities such as restrooms and handwashing stations.

Close the loop: environmental monitoring

Pack houses generally monitor microbes to comply with food-safety requirements. However, this monitoring provides little information about decay risk.

To assess whether cleaning, sanitation, and disinfection are effective, pack houses must conduct regular environmental monitoring that includes quantifying fungal spores.

Many laboratories that conduct food-safety or fruit-quality analyses offer environmental monitoring.

Primary sources

Benić L. 1999. Critical controls for inoculum reduction and postharvest decay management. Paarl: Deciduous Fruit Producers' Trust. (Available on request from Hortgro).

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Jooste M. 2024. Best-practice guidelines for cold-room sanitation. Stellenbosch: Hortgro.

The Best-practice guidelines for cold-room sanitation document is based on the following online resources (all links valid on 15 November 2026):

5 Tips for cleaning insulated panels in cold rooms.

8 Tips for properly cleaning your cold room.

Cold-room maintenance tips.

Cold-room cleaning: cleaning at low temperatures.

Commercial cold-room maintenance and cleaning tips.

Condenser coil.

Distribution centre hygiene cooling equipment.

How to clean your cold storage or refrigeration room properly.

What are the components of your cool room fan coil unit and why they need to be maintained, disinfected, cleaned and protected!

Why coolroom and cooling equipment hygiene is important.

Additional resources

Dr Johan Fourie's presentation on pack-house sanitation at the 2025 Hortgro Postharvest Symposium is summarised in the Fresh Quarterly and available on the Hortgro YouTube channel.

Arrie de Kock's Hortgro-funded research on effective fungicide application in stone fruit is summarised in the Fresh Quarterly. This issue contained several articles on postharvest diseases and decay control.