Best Practice Guidelines: Golden Delicious

1. Variety selections – Panaroma Goldens / Early Goldens & Golden Delicious

Panorama Goldens / Early Golden Delicious		Golden Delicious	
AGK	Applewaite Golden	**GDL**	Golden Delicious Elma
GJY	Golden Joy	**GED**	Golden Delicious NIVV
PNG	Panorama Golden	**SGN**	Spur Golden
GLD	Ginger Golden	**SMT**	Smoothee
EGD	Earligold	**MLD**	Mollie's Delicious
		DGL	Dorsett Golden
		SGD	Southern Gold
		SSG	Sunset Golden
		GOR	Golden Reinders
		BGS	Blushed Golden
		GKG	Golden King

2. Harvest Maturity

2.1. Picking windows

- When a picking window is set, the window can be divided in 3 periods i.e., pre-optimum, optimum and post-optimum.
- Fruit harvested during the pre-optimum period (typically the first 3-4 days after the release date) has good storage potential but acceptable taste will only develop during and after storage. The risk of superficial scald and bitter pit development exists. Long storage may be risky and cause shrivelling to develop.
- Optimum harvested fruit (middle period of 7 to 10 days) is best suited for medium (± 4-5 months) to long (± 6 months+) storage and has better taste.
- Post-optimum harvested fruit has short (± 2-3 months) storage potential but superior taste. Fruit harvested over mature in this period has potential for over maturity defects i.e., greasiness, mealiness, internal browning and decay. Overmature fruit are also more prone to yellowing and bruises.
- Fruit picked prior to the optimum stage of maturity are more prone to bitter pit than those that are picked later.

Commented [HG1]: Ek hou van opskrifte bo kolomme

Commented [LB2R1]: Ons moet seker al die dokumente ontvang op een formaat doen? Wat is jou opinie

Commented [HG3R1]: Ek stem maar almal doen hulle s'n op eie. So kom ons kyk net na die een - Bo eertse kolom - Abbreviation, Name in full - etc

Commented [HG4]: Long storage develops shrivelling.

Commented [LB5R4]: Het die sin ingebring

Commented [HG6R4]: Reg

Commented [HG7]: What is medium and long storage - define terms

Commented [LB8R7]: Ek het die medium en lang termyn stoorperiodes ingebring, stem jy saam?

Commented [HG9R7]: Reg

Commented [HG10]: Define term

Commented [LB11R10]: Ingebring, stem jy saam

Commented [HG12R10]: reg

Commented [HG13]: Yellowing and bruises easily

Commented [LB14R13]: Ingebring

Commented [HG15R13]: reg

2.2. Maturity Criteria

Cultivar	Firmness (kg)	% TSS	Starch			Acid %	Pip colour	Background colour
			Minimum average of sample	Maximum average of sample	Optimum Range (individual fruit)			
Golden Delicious	7.8kg	11.0	<15	>60	20 - 40	0.50	½ of pip brown	Max No 6 (A28) DALRRD colour chart
Panorama Golden	7.2kg	10.0	<15	>60	20 - 40	0.50	½ of pip brown	Max No6 (A28) DALRRD colour chart

Reference: Pome fruit protocols: Picking, Storage requirements for Sea Export of Pome fruit (ppecb.com)

- Record if fruit was treated with Retain or Harvista.
- Fruit with different maturity should be stored separate in CA conditions.
- Risky orchards must be identified and handled differently e.g. Young orchards, Orchards with history of bitterpit, Orchards with low crop load (big fruit)

3. Bin type & Bin conditions

- **Wood or Plastic**
  - Rigid, smooth, clean, thick bottom bins cause the least bruise damage.
  - About one-third of all apples in a bin are in contact with the bottom or sidewalls.
- Bins must be clean i.e., dust free, to prevent rub marks and bruising.
- Bins must be clean i.e., of rotten fruit. Bins host for decay pathogens and over wintering place for insects. Clean bins with sanitising agents.

4. Post-harvest drench

4.1. Increasing the Calcium content (optional)

- Bitter pit is positively correlated to fruit size, tree vigour, fruit N, fruit K and fruit Mg. Bitter pit develops in the parts of the fruit where the tissues contain inadequate levels of calcium.
- Dipping in a solution of calcium chloride or calcium nitrate is an effective way of increasing the calcium content of the near-surface fruit tissues. Dipping is seldom necessary when orchard factors are optimal and when an adequate number of calcium sprays were applied at appropriate intervals during maturation.

- Blemishing (calcium spot) of the fruit surface, and damage to the lenticels, is a common side effect.
- Drench fruit as soon as possible after picking. However, in hot conditions, if the fruit temperature is 25˚C or more, do not drench. Drenching at temperatures above 25°C can cause fine lenticel burn damage.
- If fruit is drenched with water, it is important that the water has a sanitation effect.

4.2. Sanitization (optional)

- Calcium Hypochlorite at 75-100 ppm can be used to drench the fruit for sanitization.

Commented [LB16]: Is hierdie konsentrasie nie bietjie hoog nie? Dit kan ook lentisel brand veroorsaak, veral as die vrugte baie warm is?

Commented [HG17R16]: Ek het altyd per kultivar kosnentrasie gehad.
Rooi en Granny's 0.75% en Goldens en meer sensitiewe kultivars 0.5% Kalsium nie oplossing nie.

5. Decay control (optional)

- Fludioxonil i.e., Scholar / Teacher or Pyrimethanil i.e., Protector, can be used for decay prevention.
- Optional for Long Term CA storage.
- Follow Label Instructions for dilution to achieve ppm per product.

Commented [HG18]: At label concentrations

Commented [LB19R18]: Ingebring

Commented [HG20R18]: Reg

6. Bin Intake

- Fruit should not stand outside overnight. Fruit should always be placed under cooling conditions as far as possible and temperature breaks should be minimised. Letting fruit stand overnight increase bitterpit risk.
- Harvest maturity must always be considered when loading CA rooms.

Commented [HG21]: Letting fruit stand overnight increase bitterpit risk

Commented [LB22R21]: Ingebring

Commented [HG23R21]: Reg

Variety	Long term CA		Medium to Short term CA	
Golden Delicious	Starch conversion (%)	Firmness (kg)	Starch conversion (%)	Firmness (kg)
	10-40	>7.2	40-60	6.8-7.2

- Take a representative sample size to conduct analysis on fruit. Suggested representative sample size is 10 fruit for starch and 10 fruit for pressure and sugar per PUC per orchard per intake.

Commented [HG24]: How many fruit?

Commented [LB25R24]: Ek het 'n voorstel ingesit, jy gemaklik?

Commented [HG26R24]: Reg

7. Inspection

- Post-packing inspections according to various exporters standards or minimum export standards of DALRRD (www.dalrrd.gov.za) is required.

Commented [HG27]: Post packing inspection

Commented [LB28R27]: Ingesit

Commented [HG29R27]: Reg

- Arrange with PPECB for regular inspections, in order for the fruit to be placed under forced-air cooling as soon as possible.
- Approved pallets must be in a cold room for forced air-cooling within one hour after inspection.
- Conduct shelf-life analyses to determine progressive defects e.g., bitterpit. Keep fruit at ambient temperature of 22-24˚C and test on day 3, 5,7 and 10.

8. Cooling protocol

- Yellowing and low pressures may become a problem during the season while physiological disorders such as bitterpit are also temperature related. Maintenance of a pulp temperature between - 0.5˚C and + 0.5˚ at all times is very important.
- Pallets should go into forced air cooling with a setpoint of -1˚C until the pulp core temperature have been reached.
- DAT (Delivery air temperature) can go down to -2.3°C if the ambient temperature is warm (summer) and -1.7°C if the ambient temperature is cooler (winter).
- Pallets should be kept in a holding room at a setpoint of -0.5˚C. Delivery air temperature can go down to -1°C.

9. RA period

- Panorama Golden: Pack by Week 11 for export.
- Golden Delicious: Pack by Week 12 for export, if Smartfresh treated pack by week 15.

10. Pre-sorting protocol

- Wait at least 3-5 days before pre-sorting, to avoid bruising.
- Load within 7 days from opening and pre-sorting out of a CA room.
- Pre-sorted bins should go back into cold store within 40-60 minutes from filling.

11. Storage Regimes

11.1. Regular Atmosphere Storage (RA)

- Fruit should reach pulp temperatures of -0.5˚C within 48 hours of harvest and held at that temperature during storage.
- Set-point temperature should never be lower than -1˚C.

Commented [HG30]: DAT Can go down to -2.3 id ambient is warm (summer) and -1.7 in winter)

Commented [LB31R30]: Ingebring

Commented [HG32R30]: Sit miskien in with good temperature monitoring

Commented [HG33]: (DAT?)

Commented [LB34R33]: Watter temperatuur sal jy voorstel?

Commented [HG35R33]: Fruit temperature (nie DAT nie)

Commented [HG36]: Early areas - from - to?

Commented [LB37R36]: Het jy dalk voorstelle?

Commented [HG38R36]: 1 week after first pick (Lyk of ons aan einde van week eerstes gaan kry)

11.2. Controlled atmosphere storage (CA)

- Rooms to be cooled 24-48 hours prior to loading of the CA rooms.
- Stack rooms according to the CA floor plan to maximise cooling effectivity.
- Do not over-utilise the daily cooling capacity of the room.
- Do not apply CA conditions until the fruit pulp temperature is at or below 3˚C.
- CA room loading should be done within 7 days of harvest.
- If treated with Smartfresh, it must be done within 14 days of harvest. Smartfresh protocol of 7 days from start of loading room must be adhered to.
- Within 7 days after closing the room CA conditions should be reached.
- Relative Humidity (RH) must be between +90% and 95%.
- Aim to measure the ethylene levels every 2 weeks in CA rooms to manage the sequency of opening of the CA rooms.

11.3. Recommended CA conditions

Cultivar		Gas Setpoint		Temperature Setpoint (˚C)	Storage Period (months)	Superficial Scald control options
		O_2 (%)	CO_2 (%)			
Golden Delicious	Optimum:	1.5	2.5 or 1.5	-0.5	7-9	Alt: SMF/DCA
	Maximum:	2.0	3.0	0.0		
	Minimum:	1.0	1.0	-0.5		

CA Manual Revised (2019) Recommendations for the Storage of Pears and Apples, Anél Botes, ARC Infruitec-Nietvoorbij, JA van der Merwe

11.4. 1-MCP Treatment

- **1-MCP (Smartfresh and other products) is applied to slow down the ripening process and the production of ethylene in fruit.**
- The sooner the 1-MCP treatment is after harvest the better for the fruit quality. If the room has not been filled within 7 days, a dual application must be done.
- Vents must be kept open, and rooms regularly ventilated to prevent CO_2 and ethylene build-up in the room prior to treatment with 1-MCP. If a room was closed for a few days or more, it should be flushed with fresh air before 1-MCP treatment.
- In rooms treated with 1-MCP, store fruit at +2˚C (DAT) before and during 1-MCP treatment.
- Change the temperature set point to achieve the target temperatures, after 1-MCP treatment.

12. Moisture loss (shrivelling)

- **Methods to reduce moisture loss during storage:**
- Bins should never stand outside for extended periods.
- Start cooling of fruit as soon as possible after delivery of fruit.
- 4-way bins are a good option to use to enhance airflow.
- Use of one bin type per room where possible or at least one type per row.
- For the control of humidity, CA store floors can be covered with water to restrict moisture loss. The use of humidifiers is encouraged.

Commented [HG39]: Use of humidifiers encouraged

Commented [LB40R39]: Ingesit

Commented [HG41R39]: reg

13. Wilting

- Method to reduce bruise-ability of fruit before packing.
- When opening a CA room, use John Findley's cold wilting process as explained in the CA Manual.
- Do not attempt to wilt at ambient temperature as this cause severe stress on the fruit which will break the cell wall, causing man-made bitterpit to appear.

14. Packing preferences

14.1. Controlling of Bruising

14.1.1. Bruising is a function of many variables:

- Golden Delicious is very prone to bruising.
- Some years are more bruise-prone than others.
- The more mature the apple the more bruise-prone it becomes.
- Soil moisture can influence the severity of the damage. Apples picked after rain or with soil moisture at full capacity, will bruise far more easily than fruit picked on a falling moisture regime.
- Apples picked in the early morning (with dew) bruise more easily than those picked after they have warmed up during the day.
- Momentum (mass x velocity, P = M x V) is a major driving force for bruises, coupled to kinetic energy: KE = ½ x object's mass x V^2 (Kinetic energy is equal to half of the object's mass multiplied by the velocity squared).

Commented [HG42]: Momentum (mass times velocity P=MV) is major driving factor for bruises

Commented [HG43R42]: Coupled to kinetic energy: KE) is equal to **half of an object's mass (1/2*m) multiplied by the velocity squared**

Commented [LB44R42]: Ingebring

Commented [HG45R42]: Reg

14.1.2. General Guidelines

- A good quality control or monitoring system, from picking through transport and the packhouse, is essential to prevent damage before it occurs or to halt it if any sign of bruising appears.
- Know your fruit, the stage of maturity and whether the fruit is or has become more bruise prone.
- Make sure the quality controller is properly trained and knows what he or she must look for.
- Sample fruit from various places in the packing line at least twice weekly and leave for 24 hours and then examine for bruising damage.
- A better method is to examine the fruit the next morning. The increase in the incidence of bruising will show up very clearly.
- There are several different types of electronic apples available throughout the world. This is another tool by which to select the best machine to handle fruit or to pin-point places where damage is occurring on existing machinery.
- Training is of utmost importance to get favourable results. This is a continuous process. Discipline must be enforced.

14.1.3. Receiving of Fruit Bins and Dispatch of Pallets

- Forklift operators should receive training on handling bins and pallets.
- Travel slowly to destination.
- Put bins / pallets down gently.
- No collisions – bring bins / pallets slowly into contact with other bins / pallets.
- Use full length forks on forklifts – short forklift forks usually springboard floors upwards.
- Proper container loading is essential to avoid force of last pallet into container.
- Trolley Jack operator trained in efficient loading of container.

14.1.4. Sorting

- Move non-moving fruit gently. Avoid excessive handling of the fruit.
- Care should be taken when sorting fruit into different grades.
- Lighting provided in the sorting table areas should be sufficient.
- The sorting table belts should be white or silver coloured.

14.1.5. Packing

- A packer who packs too fast can cause severe damage, misplacing apples on the edge of the carton or pulp tray or hitting another apple in the box. Monitor all packers.
- Handle one fruit per hand only.

- Push the lid down on the corners of the outer carton, not in the middle, when closing. Do not slam on the lid to close it.
- Place the carton on the conveyor belt gently, do not drop it. Make use of a carton elevator where available.
- Do not over fill the packing tables.

14.1.6. Bagging of apples

- Work on rubber padded platform.
- When packing, bag must be in contact with platform:
    - Either pack holding the bag flat and push fruit into the bag. Do not throw fruit into the bag.
    - Or roll up and place fruit in the bag. Do not drop fruit into the bag.
- Ensure placement of bags in the cartons are correct. Fruit should not press directly against each other.

14.1.7. Packing line machinery

- Ensure singulator / sizer timing is accurate.
- Synchronization between components (i.e., singulator to sizer) is important.
- The packing line should be run at speeds that keep it nearly full of apples (cup fill); run at slower speed to minimize bruising.
- Eliminate unnecessary drops and turns in the lines.
- Reduce drop heights.
- All drops along the packing line must be well padded. The padding should deaden the impact rather than making the fruit bounce and hit the next fruit.
- Curtains at each drop slow down the forward movement of the fruit.
- Conveyor belts should be suspended where apples drop to them, otherwise the apples will be bruised by the hard surface underneath the belt.
- Fruit must drop free from the rollers onto the drop board, otherwise fruit can be pinched while it is on the rollers between the drop board and the roller. Place the drop board just below the centre line of the shaft driving the rollers.

14.1.8. Palletising

- Pick up one box at a time.
- Place the cartons on the pallet gently, do not drop them.
- Use a ladder or scissor jack to put cartons on the top layers of a “High Cube” pallet – do not throw the boxes on the pallet.
- At pre-sorting, avoid overfilling of the bins.

14.2. Packaging Types

- Packaging is not used only as means of transport for the fruit. It should also allow sufficient cooling, ensure colour is maintained, prevent progressive defects and prevent bruising.

14.2.1. Carton design for effective cooling

- Sufficient ventilation of cartons is crucial to ensure that fruit is effectively pre-cooled and that the cold chain is maintained throughout the handling process.
- Airflow consists of both a horizontal and a vertical component. Sufficient horizontal airflow is required for pre-cooling in forced-air cooling tunnels where air direction is horizontal. In integral reefer containers and specialized reefer vessels the air flow is vertical and therefore cartons should provide for vertical airflow.
- Air holes at the bottom of the carton are important for vertical cooling. The amount and spacing of these air holes are a function of paper combination, type of inside packaging and type of wooden pallet used. It is recommended that at least 5% of the surface area on such surface be open for air flow. There are also some "Super Vent" carton designs available to the industry and these should be seriously considered. The carton type will shorten the pre-cooling times, which will benefit fruit quality in certain instances.
- Inner packing material in most cases unfortunately blocks off ventilation holes. This applies especially when plastic bags are used. Keep this in mind when deciding on final pre-cooling practices or temperature regime within containers.

14.2.2. Plastic bags – To maintain colour

Variety	Colour Bag	Micron
Golden Delicious	Mostly Green, check supermarket specification	Micron important, different options available

Reference: Pome Fruit Packaging Guidelines

- Apples should be kept in containers lined and covered with polyethylene to help retain the humidity.
- After packing the bag must be folded carefully and the last fold tucked in firmly between the wall of the cartons and the outside of the bag when packing in a Mk4, Mk9, and Mk7 carton, or use other methods to prevent the bags from blowing open.
- Plastic liner bags: Function is to increase CO_2 concentration causing a reduction in bitterpit and reduce ethylene induced yellowing due to CO_2 competition at binding sites. It can also function as a 'cool bag' in poor cold chains, controls humidity loss and maintains freshness.

Commented [HG46]: Remember liner bags contradicts everything one says seeing that it block vents

Commented [LB47R46]: Sy noem dit in haar laaste punt:Inner packing material in most cases unfortunately blocks off ventilation holes. This applies especially when plastic bags are used e.g., for Golden Delicious. Keep this in mind when deciding on final pre-cooling practices or temperature regime within containers.

Commented [HG48R46]: Reg

Commented [HG49]: Plastic liner bags:
Function to increase CO2 concentration - reduce bitterpit and reduce ethylene induced yellowing due to CO2 competition at binding sites.
Other uses - can function as "cool bag" in poor cold chains.
Also controls humidity loss - and maintains freshness.
Thickness of bag
MK9 - 20 mikron - due to difficult in sealing bag - so in effect just humidity barrier.
Mk4 - normal cold chains 37 micron
MK4 - poor cold chains 65 micron

Commented [LB50R49]: Ingesit

Commented [HG51R49]: Reg

14.2.3. Thickness of bags:

- MK4 – 65 microns for poor cold chains
- MK4 – 37 microns for normal cold chains
- MK7/9 – 20 microns (bag is difficult to seal, so in effect it only serves as humidity barrier).

15. Logistics

15.1. Optimum shipping conditions

- Temperature: - 0.5˚C
- Relative Humidity: 90-95%
- Vents closed
- Reason for closed vents: vents allow tropical air to ingress cooling unit which increases the defrost cycles and therefore cooling.

15.2. Cooling Guideline for Golden Delicious and Panorama Goldens

Cultivar	Load Out Temp	Set Point	Code	Vents
Panorama Golden*	-1.0˚C to +1.5˚C	-0.5˚C	D-0.5	Closed
Golden Delicious	-1.0˚C to +1.5˚C	-0.5˚C	D-0.5	Closed

Reference: HP28 Handling Procedure and Optimum Temperature Requirements for Sea Export of Pome Fruit – PPECB

* Load Panorama Goldens packed in first week from harvest at 0°C

** If TSS is >13%, ship at +1°C – D1 (For Panorama Goldens and Golden Delicious)

- Please be aware of the challenges at the Nigerian / African ports.
  - Loadshedding and intermittent cooling occurs that can cause up to 8-day delays to clear containers in port.
  - Clear the levels of responsibility with the insurer.
  - Add cell phone enabled temperature loggers in containers to monitor the temperature at the ports.

16. References

- Bruising and its control – Finlay
- Pome fruit protocols: Picking, Storage & Handling (HortGro)
- DFPT Research Bitter Pit Pamphlet
- CA Manual Revised (2019)
- Pome Fruit Packaging Guidelines
- Basic Cooling Guidelines for Pome Fruit

Commented [HG52]: First weeks Panorama - load at 0C
If TSS is above 13 - ship at -1C - D1 (also for Goldens)
Vents - reason for vents closed:
Anyway in plastic liners
Vents allow tropical air to ingress cooling unit which increases defrost cycles and therefore cooling

Commented [LB53R52]: Ingebring

Commented [HG54R52]: Moet minus 1 wees en nie een nie

Commented [HG55]: Put in paragraph about Nigerian/African ports
Load shedding and intermittent cooling occurs at this and several other African ports
Takes up to 8 days to clear container in port
Clear with your insurer levels of responsibility
Add cell phone enabled loggers to container to monitor containers at Nigerian port.

Commented [LB56R55]: Ingebring

Commented [HG57R55]: Reg

- HP28 Handling Procedure and Optimum Temperatures for Sea Exports of Pome Fruit (www.ppecb.com)
- HP22 Temperature Regimes
- PPECB Blue Book