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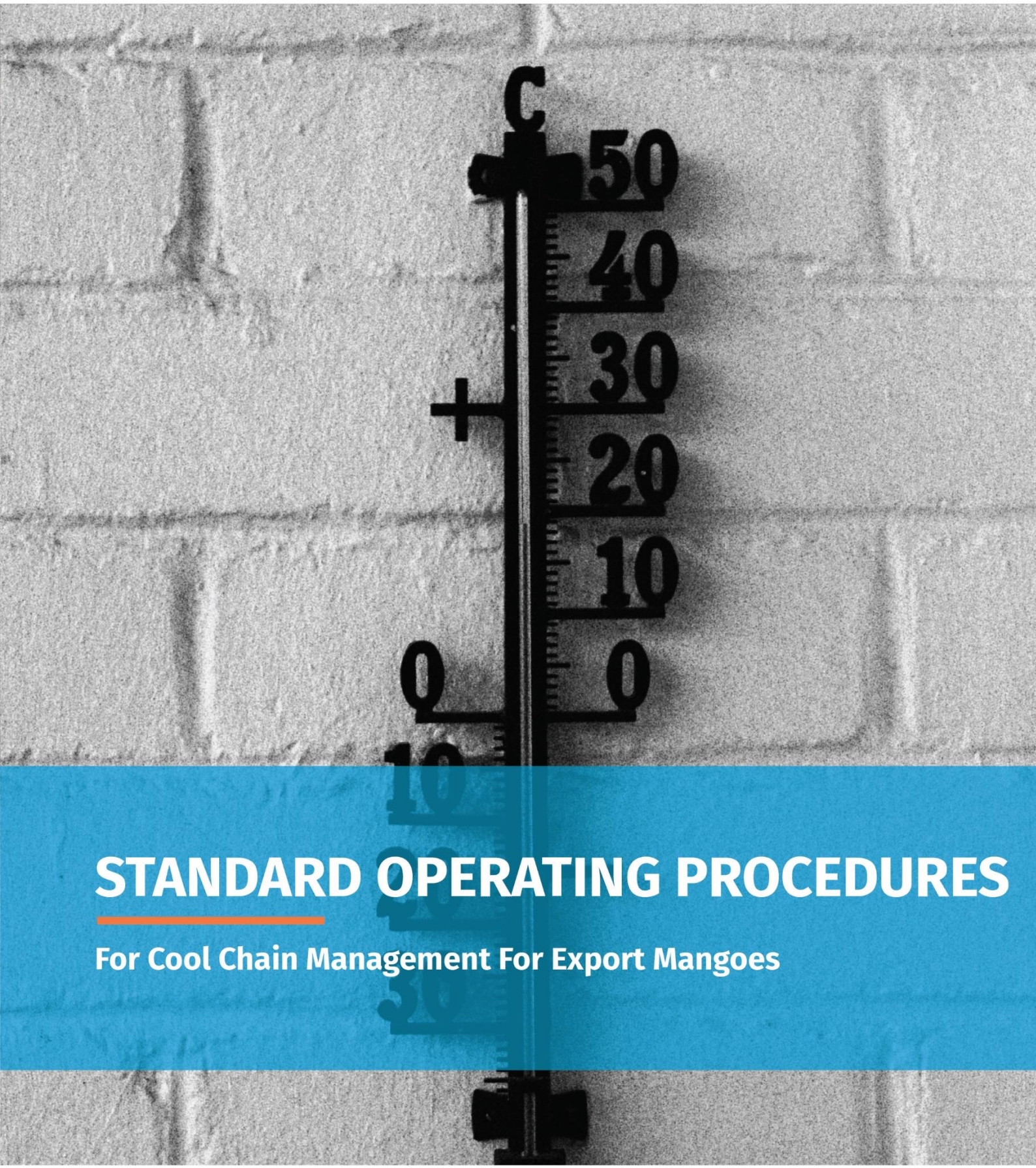

STANDARD OPERATING PROCEDURES

For Cool Chain Management For Export Mangoes

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Disclaimer

Contents

Acronyms

CA	Controlled atmosphere
cfm	Cubic feet per minute
cfs	Cubic meters per second
DC	Distribution center
HWT	Hot water treatment
MA	Modified atmosphere
SOPs	Standard operating procedures
VHT	Vapor heat treatment

1. Scope of SOP Document

The scope of this document is to provide the standard operating procedures for the cool chain management of fresh mangoes to meet the requirements to export to a modern retail system.

This document can also be used as training and reference resources for Agricultural Extension Centers, Vietnam Fruit and Vegetable Association, or agricultural students at Universities and Colleges.

2. Key Definitions

Field Heat is the difference between the temperature of the harvested crop and the optimal storage temperature of that product.

Forced Air Cooling is accomplished by exposing packages of produce in a cooling room to higher air pressure on one side than on the other. This pressure difference forces the cool air through the packages greatly increasing the rate of heat transfer.

3. Introduction

Mango belongs to the climacteric fruits category, these are fruits that they continue to ripen after harvest. During the ripening process, the fruits emit ethylene along with an increased rate of respiration. This process must be managed throughout the cool chain to maximize shelf life and obtain the best quality out-turn.

The document is intended to assist the export supply chains from field production to retail in the cool chain management requirements of mango to meet its necessary specifications, standards and shelf-life.

This document applies to mango business and personnel involved in the export mango chain such as producers, farm managers, extension officers, collectors, packhouses, service providers, transporters, exporters, and retailers.

This document is intended to be read in conjunction with the following SOP documents:

- SOP No.1: Standard Operating Procedures for Field practices for export quality management.

- SOP No.2: Standard Operating Procedures for export mangoes packing house
- SOP No.3: Standard Operating Procedures for disease management of exported mangoes
- SOP No.4: Standard Operating Procedures for cool chain management of exported mangoes
- SOP No.5: Standard Operating Procedures for transportation of exported mangoes
- SOP No.6: Standard Operating Procedures for traceability of exported mangoes
- SOP No.7: Manual for mangoes export market requirements.

4. Principles of this SOP

Management of Field Heat

Practices that are targeting removing, reducing and/or maintaining the temperature that is present within harvested fruit, and other critical points in the chain where fruit can be exposed to higher temperatures. Quick removal of field heat and minimizing temperature fluctuations within the fruit can substantially increase the shelf life and reduce disease expression. In general, the product should be cooled down till its temperature reaches 88% of the existing difference in temperature and its optimal storage temperature. For example, “Cat Chu” mango’s post-harvest temperature is 30^{o}C, while the optimal preservation temperature is 13^{o}C; it means the mango has to be pre-cooling to 15^{o}C (cooling 88% field heat)

Temperature Management Practice and Systems

Transportation practice can greatly influence fruit pulp temperature. Airflow, packaging design, load configurations, refrigeration cooling and ambient temperature conditions all have a role in how the temperature is managed throughout the supply chain. Different temperature management systems require sets of operational procedures to maximize their efficiency in maintaining an export cool chain.

Physiological Process

Mango is a climacteric fruit and will generate significant amounts of heat during the ripening process. Exposure to ethylene, and/ or higher temperatures can trigger the ripening process, which must be managed throughout the supply chain to maximize fruit shelf life.

Compliance and Record Keeping

Verification of management practices meeting standards, regulatory, quality, environmental, health, traceability, and safety requirements.

5. Management of Field Heat

5.1. Harvesting

5.1.1. Time of Harvesting

The time of harvest significantly affects fruit pulp temperature. Fruits harvested during the cooler time of the day will have a lower pulp temperature. This makes maintaining the pulp temperature to the packhouse easier. The recommended time for harvesting mature fruits is from 9:00 in the morning to minimize fruit temperature and avoid the high latex flow that occurs very early morning.

5.1.2. Crates

Plastic crates are the most suitable field containers for export fruit. They need to have large ventilation slots allowing air exchange to avoid excessive heating of fruit. Plastic crates should not be left exposed to the sun but should be stored in a clean and shaded area. Crates must be cleaned before use and free from any contamination (sap, soil). Should be covered with a spongy net for the fruit in contact with the basket to avoid scratching. The quality of the plastic basket material must be in accordance with QCVN 12-1.

5.1.3. Holding Fruit on Farm

Harvested fruit in crates are to be held in a clean and fully shaded area, avoiding sun exposure. If such a site is not available then the crates need to be covered with a light reflective covering e.g. such as bed sheet.

Harvested fruit should not be held on the farm longer than 6 hours before transporting to the packhouse.

5.2. Training Requirements

The farm workers will be trained in good agricultural/horticultural practices for management of field heat, crate selection care and maintenance, packing of fruits into field crates and protection of the fruit from heat.

5.3. Records and Documentation

Records of the harvest date and time, and time of consignment to the packhouse. The fruit should not remain on the farm for more than 6 hours.

6. Transportation Temperature Management

6.1. Transporting Fruit to Packhouse

Ensure plastic crates being used are adequately ventilated and not over filled to avoid compression damage. Stack neatly onto truck or other transportation vehicle. Preferably used a covered vehicle, if not available cover the load with tarpaulin ensuring that it will allow some ventilation but prevent direct sun contact with the top crates. Use light colored material as cover as this will reflect heat. Transport fruit during cooler parts of the day as late afternoon, evening or morning.

Unload immediately when coming to the packhouse and place containers of fruits in a clean, dried, well-aired and shaded area.

6.2. Packhouse Procedures

Fruit needs to be handled within 12 hours of receival at the packhouse. Maintain fruit at ambient temperature prior to packing. If the packhouse is not air conditioned, then precooling the fruit before packing will lead to excessive fruit sweating and potential skin damage.

If fruit has to be held for longer periods before packing and there is no

rature control in the packhouse then it should not be stored below 18^{o}C – 22^{o}C. If no cool rooms are available, then fruit that has to be held for longer periods should not be used for export.

On completion of the packhouse processes (grading, desapping HWT, packing) then the fruit needs to be cooled to the holding temperature as soon as possible. Once fruit enters a cool chain it must stay within the chain, cooling and heating the fruit will reduce its shelf life. Understand the fruit pathway to determine when to begin to cool. For example, fruit that is to be VHT treated should not be

precooled before treatment, fruit not being VHT treated needs field heat to be removed as soon as possible post packing.

Fruit should be placed in a cool room after packing at a set between 12^{o}C and 15^{o}C The cooling temperature regime must be aligned with the market that it is being sent.

6.3. Load Cooling

6.3.1. Before Starting Load Cooling

Organise commissioning and testing of cool rooms. Cool rooms must be calibrated to ensure that the thermostat is accurate, this can be conducted by a refrigeration technician. Request a calibration certificate.

Check that the plug and socket are good, clean and dry, check the power supply is secure. If the 3-phase power is 380V/440V, the minimum must be 380V and the maximum is 460V, if the 3-phase power is 220V, then minimum 190V and maximum 230V, then plug the power plug into the electrical outlet.

Run the cool rooms for 24 hours and monitor temperature placing the temperature monitoring device in the warmest part of the room, this can be near the doorways or when loaded at the return air inlets on the refrigeration units.

6.3.2. Room Cooling

Room cooling rates will be affected by the amount of air moving across and through the package. It is recommended that air velocities around packages should be from 1 – 2 m/s [8], [18]. However, whether this is sufficient will depend on the produce temperature, type, and surface area relative to volume.

To increase the surface area products must be widely spaced, align with adjacent boxes and provide space in between stacks and between stacks and walls when stacked to allow air to circulate in the stacks of cartons. The strength of the carton lies in its corners. Stack the cartons neatly to avoid crushing the boxes below. The height of the stack will be determined by the grade of the board used in the carton.

Room cooling is also space inefficient; it can also increase the load on the refrigeration system if warm products are constantly being added to the room.

Figure 1: Instructions for arranging packages in the cold room

6.3.3. Forces Air Cooling

Forced air cooling is the quickest way of removing field heat from fruit but will require the correct infrastructure and management of the cooling process to avoid unseen quality issues. Forced air or 'pressure cooling' effectively increases the surface area being cooled from that of the package to that of the produce inside. It can reduce cooling times by 10 times or more, compared to room cooling. Most forced air systems are designed for two rows of stacked pallets to be placed against a central plenum. A tarpaulin is draped over the top to block the gaps between the pallets, forcing air through the carton side vents. Excess spaces such as pallet gaps need to be filled with cardboard.

Forced air systems need to pull cold air through vented packages at rates varying from 0.1 to 2.0 L/second/kg of product. A general guide to fan strength is that there should be enough pressure to hold a piece of A4 paper against one of the carton vents.

For forced air-cooling to be efficient, cartons should have vents covering at least 5% of their surface area at the air entry and exit points. The vents must line up between cartons, even if pallets are cross stacked. Note that one or two large holes allow more air movement than many small holes, even if the total area is the same, due to the edge effect around vents.

Do not force air cool loads below 12^{o}C as this will greatly increase the incidence of chill damage, it is important to monitor the air on the supply side to assure that this does not drop below 12^{0}C.

Monitor internal fruit pulp temperature from fruit near the center of the pallets with internal fruit temperature probes.

Once fruit is cooled it can be held in cool rooms till ready for dispatch.

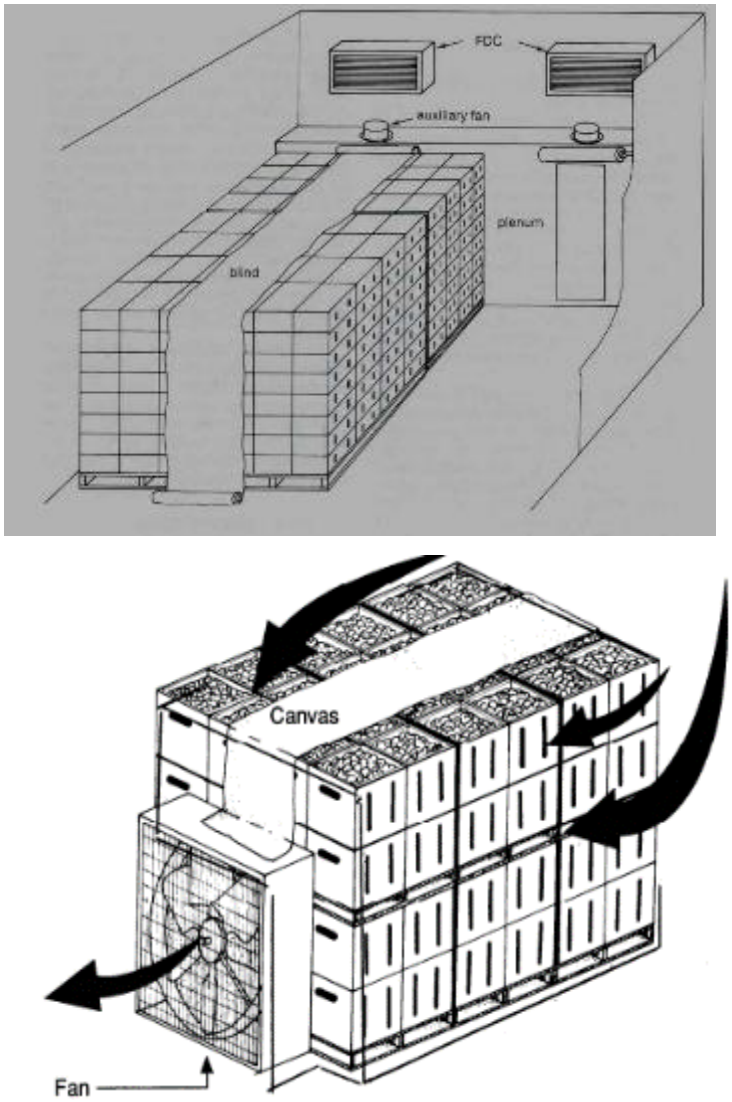

Figure 2: Instructions for arranging packages in the forces air cooling room

6.4. Transporting to Export Hub and/or Service Providers

Refrigerated transport systems are designed only to maintain the temperature of the produce. That is, they need only to compensate for respiration and heat gain from the exterior. Fruit must be pre-cooled to set temperature before

transported to export hubs. Transportation temperatures should be between 12 and 15ºC, this may vary slightly with different varieties. (5 to 12°C for some mango varieties such as Keo mango, Taiwanese mango (Tuong da xanh mango).

6.5. Carton Design

Cartons or fiberboard boxes must have either adequate ventilation holes at the sides or be open top cartons with no lid, this is essential for airflow across the fruit. Ventilation hole design is balanced between providing good ventilation without compromising mechanical strength. Ventilation holes must align with the next carton when stacked on a pallet. Phytosanitary requirements for some countries will require ventilation holes covered with insect-proof screens of a minimum of 30 meshes per linear inch. For example, for the Australian market, the hole size is not larger than 1.6 mm and the thread thickness is not less than 0.16 mm [15].

Cartons must be of sufficient strength to withstand stacking, palletizing transport and high humidity which reduces carton strength. Cardboard must be of a good grade to ensure sufficient carton strength, bursting strength of the cardboard should be 17.5-19.3 kg/cm2. Two-piece carton is preferred for airfreight and single piece open top carton for sea freight to allow better ventilation.

If two-peice cartons are being used for sea freight, then they will require ventilation holes in the bottom and top of the carton. Ventilations holes must line up when the cartons are stacked on a pallet.

Use an interlocking type preferably having a water-proof coating to prevent damage due to high humidity during cold storage. Only packing material of food grade is used for packing mangoes at the pack house facility. Carton size will vary according to importing markets requirements. Common export cartons are 4 to 5 kg.

6.6. Phytosanitary Treatments

6.6.1. Vapor Heat Treatment (VHT)

Fruit should not be precooled before VHT treatment if it has to travel some distance to the VHT plant then transportation temperature should not be below

18°C, post treatment fruit needs to be cooled rapidly, this can be either hydra cooled or air cooled.

VHT treated fruit should be cooled prior to packing. For cooled mangoes, pack the fruit as soon as possible after cooling to minimize re-warming of the fruit.

Forced air cooling is the preferred method reducing the pulp temperature to the set temperature at 12-15°C, alternatively with sensitive varieties this can be done staggered by forced air cool to 15°C then gradually cool to the container set temperature e.g., 12°C, to reduce chill damage.

If necessary or desired to hold the fruit for 12 to 24 hours after cooling and before packing, transfer the field crates of fruit to a cool room at 10 to 15°C (50 to 59°F). VHT treatments can accelerate the ripening process therefore fruit must be put into a cool chain once leaving the VHT facilities.

6.6.2. Irradiation

Irradiation treatments do not heat the fruit to any significant extent; therefore, to maximize the shelf-life fruit being irradiated should be put pre chilled and placed in a cool chain once leaving the packhouse. Irradiation facilities should have some level of temperature management capacity, so fruit temperature is maintained pre and post treatment. Cooling cartons with insect mesh across the ventilation holes as required by irradiated fruit is difficult; therefore, precooling and maintenance of the chain throughout the irradiation process is imperative.

Protocols for irradiation are determined by the importing country and may vary. Check with PPD for current protocol conditions required for the export destination.

6.7. Export systems

6.7.1. Airfreight

Often airfreight facilities have limited dedicated cool room capacity and loads can sit at ambient temperature for hours before loading. Fruit should be cooled to 12-15°C and held as long as possible at these temperatures before transport for loading onto the plane. It is important to understand what facilities are available at the airport and to minimize the breaks in the cool chain. Choose flights during the cooler times of the day if limited cool chain facilities are available.

Airfreight utilizes two different systems of carrying export produce either an air pallet which is a 600 kg (approximate capacity) pallet that fits into the general cargo hold or an air container which is a small, sealed container approximately 1,200 kg capacity (container AKE or LD3, Pallet PMC).

Air pallets allow better ventilation than AV's which can help prevent premature ripening. Cargo holds are often set to a low temperature 2-5^{o}C which usually is out of the control of the exporter, for short duration flights for transportation of ripe mangoes and irradiated mangoes. This is not too much of a problem but for long duration flights, protective coverings over the loads are necessary to avoid cold damage to mangoes.

It is important the fruit is mature, as it will be less susceptible to cool temperature fluctuations that can occur in the cargo holds.

6.7.2. Sea Freight

Sea freight utilizes 20-or 40-feet refrigerated containers. These can be in the form of standard reefers, controlled atmosphere containers or modified atmosphere containers while the different containers will change the atmospheric conditions surrounding the load, they all use the same refrigeration system. With all shipping containers air flows from the floor upwards. Therefore, when loading, avoid gaps between pallets and ensure that any empty floor space is covered, so as to force the air through the pallets of fruit.

Temperature settings will vary between loads depending upon the variety, maturity, and distance to its destination. As a rule, containers for export mangoes are set between 8 to 12^{o}C. Green eating varieties of mango are often set at lower temperatures 6-8^{o}C, these temperatures however are not suitable for many varieties and can lead to chill damage. Humidity in the container needs to be between 85-95% to avoid dehydration.

Containers do have the refrigeration capacity to cool fruit but loads should be cooled as close as possible to the set temperature before stuffing the container. Temperature settings need to be determined by the distance needed to travel, stage of fruit maturity and optimum varietal parameters. Pre-cool the container to the set temperature before loading.

6.7.3. Road Freight

Fruit must be precooled before loading as truck refrigeration systems do not have load cooling capacity. Fruit needs to be pre-cooled down so that the core pulp temperature is at the set transportation temperature before loading. Pre-cool the truck to the set temperature before loading. Refrigeration systems should not be switched off during the transportation from packhouse to destination. Depending on the destination and variety loads will need to be set between 12 to 15^{o}C.

If fruit is well advanced or has begun to ripen, then loads need to be ventilated to avoid excessive buildup of CO_2 and maintain the humidity around 85 to 90%.

6.8. Post Arrival Management

Mangoes should be unloaded directly from the container or trailer onto a refrigerated receiving dock at the importer or supermarket distribution center (DC) in order to maintain the integrity of the cold chain. Holding time on the receiving dock if it is not temperature controlled should be limited to that required for identifying and recording the load and retrieving temperature recorders.

Marine container and truck trailer reefer units should be turned off while they are being unloaded. Running reefer units while unloading the cargo can cause the transfer of unwanted hot or cold ambient air and exhaust fumes into the cargo space.

Post management temperatures will need to reflect the maturity state of the fruit, and the receiver's requirements.

- Fruit ripening maintain 18 to 22ºC.
- Holding 12 to 15ºC
- Distribution transportation at 12 to 15ºC or 6 to 8ºC for some mango varieties such as Keo mango, Taiwanese mango (Green-skinned elephant mango).

6.9. Non Refrigerated Temperature Management Systems

This is suitable for short local supply chains where access to cool chain infrastructure is limited. In the export system this is predominantly to manage fruit from the farm to the packhouse.

Conduct procedures such as harvesting in the cooler parts of the day, always protect fruit from direct sunlight once harvested. If fruit becomes wet post-harvest either via desapping procedures or rain, make sure it dries as quickly as possible. Use well-ventilated plastic crates that will allow air movement around the fruit.

Utilize the cooler parts of the day to transport fruit from farm to packhouse.

For VHT systems hydro cooling is often used to lower the temperature of the product in pallets or large containers prior to further packaging. This system is not recommended for field use due to the logistical challenge of transporting sanitized water to the field and the potential risk of damage to the fruit skin from prolonged exposure to water.

6.10. Conventional Refrigerated Systems

These are standard systems that are found in cool rooms, refrigerated trucks and reefer shipping containers. Conventional cooling systems are not particularly efficient at cooling large loads of fruit, palletized fruit at ambient pulp temperature can take up to 24 hours to reach a low transportation temperature of 12^{o}C.

It is necessary to understand the cooling capacity of the system being used, so loads do not exceed this capacity. This will also determine if the system has the capacity to cool a load or only maintain the temperature of a precooled load.

Refrigeration capacity in mango storage rooms should be sufficient to maintain uniform product temperature (within 1°C [2°F]) throughout the load. This requires both sufficient cooling capacity and adequate air circulation.

A rule of thumb for airflow in cold-storage rooms used for room cooling is 0.052 to 0.104 cubic meters per second (cms) per 1,000 kilograms of produce capacity (100 to 200 cubic feet per minute [cfm] per ton).

To maintain produce temperature, a lower airflow of 0.0104 to 0.0208 cms per 1,000 kilograms of produce capacity (20 to 40 cfm per ton) is all that is required.

Refrigerated systems can dry out the air and therefore it may be necessary to humidify storage rooms if fruit is likely to be held for more than a few days. The ideal relative humidity range for mangoes is 85 to 95%.

The humidification system should be able to maintain uniform (within 2 to 3%) relative humidity levels and be designed to distribute the moisture uniformly throughout the storage space. This minimizes problems with condensation, which can lead to weakening of fiberboard cartons.

6.11. Forced Air Systems

These systems are only for cooling loads not for storage conditions.

Forced air systems can be a fixed unit within the cool room. This needs to be designed correctly to be able to deliver the required airflow whilst not exceeding the cooling capacity of the refrigeration unit.

If this forced air system is not available a simpler system of air stacking the cartons within an existing cool room and using electric fans to move air through the cartons will reduce the cooling time compared to conventional room cooling.

6.12. Calibrations

Cooling systems must be calibrated to ensure the thermostats are accurate. This should be conducted at the beginning of the season. Regular checking of the system is essential. This can be conducted with calibrated thermometers and fruit temperature probes, as well as wind speed measuring instruments. It is recommended to send the equipment to testing centers for verification once a year.

6.13. Training Requirements

Packhouse operators, supervisors, exporters, and quality supervisors need to be trained in temperate management systems and process including carton designs, load configuration, cooling regimes, cool room calibrations and temperature monitoring.

Cool chain operators should be trained in different cooling systems, understanding the operation of and constraints. Organize informal training of staff on monitoring and recording of temperatures within the cool chain annually or with new employees.

6.14. Documentations and Record Keeping

Calibration certificates and temperature logs and records of setting of cool rooms and transportation should be kept and be readily available if required. Temperature measurements taken should include internal pulp temperature.

Verification of the cool chain system can be undertaken, if necessary, with the inclusion of transit loggers in the load.

7. Managing the Ripening Processes

7.1. Fruit Maturity

Fruit maturity affects chilling injury susceptibility. In general, chilling injury decreases as the fruit develops, matures and ripens. Thus, immature fruit are more susceptible to chilling injury than fruit undergoing ripening. It is important to harvest the fruit only when it has reached the appropriate level of maturity.

7.2. Managing the Ripening Process

Mangoes are a climacteric fruit and will produce heat during the ripening process. This must be managed in the load as it can lead to excessive heat production and a shortened shelf life. This process can be slowed down with cooler temperature settings.

Always keep consignments at the same stage of maturity. Never mix ripened or partially ripe with green mature fruit.

Avoid breaks in the cool chain where heating can occur and trigger the ripening process.

Match the set transportation temperature with the maturity state of the fruit and distance to travel.

During fruit ripening, maintain temperatures between 18 to 22°C (68 to 72°F).

- High temperatures (above 22°C) reduce skin yellowing resulting in blotchy green, soft fruit and increase rot development.
- Low temperatures (below 18°C) also affect skin yellowing resulting in the skin being a pale yellow colour when ripe. More rots will also develop, and flavour will be poor (Brecht 2017).

7.3. Managing Fruit Respiration and CO_2 Production.

Increases in temperature will increase the rate of respiration. An increase from 20^{o}C to 25^{o}C will almost double the respiration rate. A by-product of respiration is carbon dioxide (CO_2), which greatly increases during the ripening

process. High CO_2 levels can have significant impacts on the fruit quality, particularly skin colour, as well as posing a hazard for cool room operators.

CO_2 levels must be managed in the cool chain and maintained below 1%. Instruments are available to monitor the gas levels but as long as a venting program is in place it will remain below this level. After ethylene exposure, ripening rooms must be vented every 6 to 8 hours, by opening the doors for 15 minutes to flush the room. Regular cool storage rooms must also be vented on a regular basis. Fruit transported in the cool chain must be done under ventilated conditions.

7.4. Managing Ethylene Production

Mangoes produce relatively low levels of ethylene but are sensitive to exogenous ethylene applications. Some importers using air freight will require pre-ripened fruit. This is conducted in a suitable temperature-controlled room where ethylene is introduced either via gas injections or catalytic ethylene generator. Ripening room temperature needs to be maintained between 18 to 22°C (65 to 72°F). Treat with an ethylene concentration at 100 ppm for 36 to 48 hours to trigger the ripening process, CO_2 needs to be maintained below 1% (Barmore, 1974; Kader and Mitcham, 2008).

It is necessary to locate ripening rooms away from storage areas containing produce that could be damaged by exposure to ethylene. Pure ethylene gas is potentially explosive and extreme caution and appropriate safety measures must be in place for its use.

7.5. Determining Temperature

Many factors need to be considered at the stage of ripeness, current process being undertaken and the variety to determine what temperatures should be used.

Below 10^{o}C	Sea export only for green eating varieties.
10-12^{o}C	Sea export temperature and storage
12-16^{0}C	General transportation temperature
18-22^{o}C	Optimum Ripening temperature
Greater than 24^{o}C	Too warm

7.6. Training Requirements

Management of cool rooms, ventilation, and fruit ripening procedures,

7.7. Documentations and Record Keeping

Documentation of time fruit is exposed to ethylene, process and concentrations used, temperature settings and recording of ventilation procedures.

8. Compliance and Record Keeping

While there are no regulatory requirements applicable to mango cool chains importing customers will often have their specifications and standards that may need to be applied, it is important to communicate with importers and exports on cool chain requirements.

9. Occupational Health and Safety

Cool rooms can present some safety issues particular with the buildup of CO2 gas from fruit ripening. This must be managed with ventilation to ensure levels do not exceed 1%. If cool room operators are using ethylene gas, then training on its safe use and handling is essential.

There must be clear warning signs and instruction boards in Vietnamese and the common language on safety procedures for machines, equipment, materials and substances.

Safe operating procedures need to be applied to refrigeration systems according to classification in TCVN 6739:2015 include: Using refrigerants of groups A3, B2L, B2, B3; using refrigerants of group A2 with the amount of charge into the system from 1.5kg or more; using refrigerants of groups A1, A2L, B1 with the amount loaded into the system from 5 kg or more. Distribution equipment, explosion prevention switch (magnetic starter, soft starter, automatic circuit breaker, inverter, leakage current relay).

Periodically inspect and maintain machines, equipment, cold storage following a safety technical inspection process: Circular 54/2016/TT-BLDTBXH promulgating 30 technical safety inspection procedures for machines, equipment and materials with strict requirements on occupational safety under the management of the Ministry of Labour, Invalids and Social Affairs (Vietnam)

10. Environmental Management

Comply with Law No. 72/2020/QH14 on environmental protection in manufacturing, trading, and service provision:

Article 53: Environmental protection in manufacturing and business establishments.

Article 61: Environmental protection in agricultural production.

Article 65: Environmental protection in transport.

Article 70: Environmental protection in goods import and transit.

11. Relevant Publications

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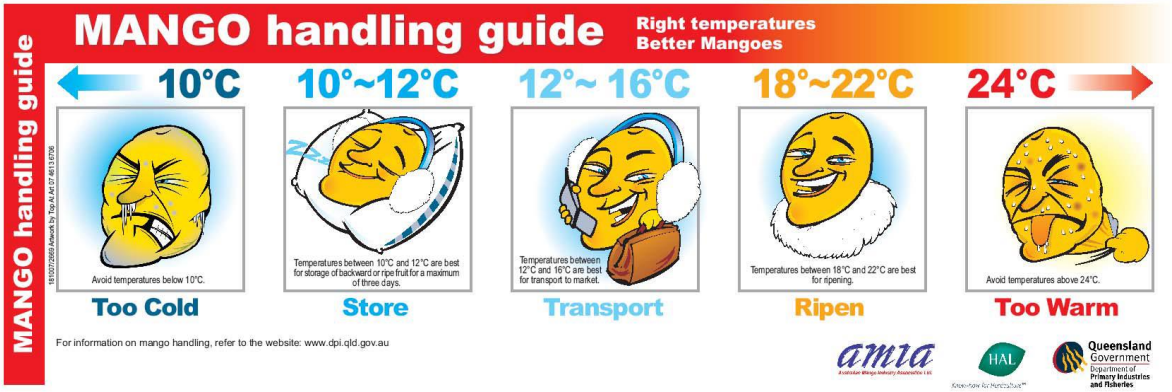
13. Appendixes

Appendix 1: Temperature Handling Guide



Appendix 2 Documentations and record keeping Checklists.

GENERAL INFORMATION – MANGO FARM

Temperature Data to be recorded in ºC or ºF (circle one)

Air temperature: _____ºC Relative humidity: _____% Rainy season: Yes/No

Irrigation prior to harvest: Yes / No Date of last irrigation: _____ Pesticide use at harvest: Yes / No

Harvest Operations: Use of Clippers: Yes / No Use of ladders: Yes / No Harvest Aids: Yes / No

Maturity indices employed at harvest (circle): Days from flower to harvest Shoulders Size Weight Peel color Flesh color Brix

Other maturity indices: _____ Observations: _____

Harvest crew training: Yes / No Wages based on (circle one): Time / Weight / Units Others: _____

Peduncle left on fruit: Yes / No Average Length: _____cm Shape after harvest: Yes/No

Latex (sap) removal practice: _____

Mango sorting at farm: Yes/No Fruit wash at farm: _____ Time lapse before shipping: ____min

Distance from farm to packinghouse: _____km Transit time from farm to packinghouse: _____min

Transport type: Open bed truck / Covered Truck / Other Transport during: Morning /Afternoon /Night / Anytime

Comments:

_____

_____

_____

POST HOT WATER TREATMENT COOLING PROCEDURES (ROOM COOLING)

Waiting time before packing: _____min. Air temp at wait area: _____^{o} Fans for air circulator: Yes/No

Approximate pallets spacing: _____cm between rows _____cm between lines

Air temp at packing area: _____ ^{o}C

Comments:

_____

_____

_____

_____

_____

_____

MANGO PACKING LINE

Packing Line Entry: Dry Dump: _____ Manual: _____ Automatic: _____ Wet Dump: _____ Manual: _____ Automatic: _____

Drops : Yes / No 90^{o} Turns (#): _____ Other comments: _____

Waxing: Yes / No Wax formulation: _____ Air dry: Yes / No Air temperature for drying: _____^{o}C

Fruit sorting at packing tables: Yes / No Adequate cushioning for packing tables: Yes / No

Adequate lighting for packing tables: Yes / No

Carton assembly: Manual / Machine Adequate carton venting: Yes/No Carton burst strength (psi) _____

Vents align in pallet: Cross stacking in pallet: Yes/No Number of boxers per pallet: _____ Number of straps: _____ Yes/No

Pallet dimension (footprint): _____x_____ cm Braces: Cardboard / Plastic

Comments:

_____

_____

_____

_____

_____

_____

COOLING AND LOADING PROCEDURES

Storage room temperature: _____°C Relative humidity: _____% Force-air cooling: Yes/No Duration: _____min
Force-air temp gradient: coolest location (outside, next to fan) ____°C Warmest location (inside, farthest from fan): ____°C

Force-air humidification: Yes / No Relative humidity: _____% Wood pallet vent blocking: Yes/No

Refrigerated loading dock: Yes / No Sea container inspection and pre-cooling before load: Yes/No Temp. setting: _____°C

Humidity set point: _____% Air exchange setting: _____CFM Utilization of temp recorder: Yes/No

Cooling equipment manufacturer: Thermo King / Daikin / Carrier Power generator location: Nose mounted / Belly mounted

Location of temp recorder (s): _____# of carton in shipment: _____

Stowage pattern: _____ Stacked above red line: Yes / No Bl king / bracing: _____

Container drains closed: Yes / No Air shocks on truck: Yes / No Approximate distance to shipping port: _____km

Controlled atmosphere setting: _____ BL#: _____

Container #: _____ Vessel/voyage: _____

Load port: _____ Finaldestination: _____

Discharge port: _____ Consignee: _____

Estimated voyage duration: _____days

Comments:

_____

_____

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UNITED NATIONS
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