Agribusiness Development Project

POST HARVEST HANDLING GUIDE
for
MOLDOVAN PEACHES AND NECTARINES

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1.0 Introduction

In Moldova old orchards of peaches are being replaced by new orchards, and growers are making greater investments in farm infrastructure, as they become aware of high value markets in the west, and realize that participation in those markets requires improvements in production, quality and presentation, as well as changes in attitudes to marketing.

It is very clear that producers in Moldova have a good understanding of cultivation techniques for peaches and nectarines, and have the support of knowledgeable local technical assistance when it is needed. However, estimates suggest that 5-25% of produce harvested cannot be sent to market, because of damage and disease caused by poor harvesting and post harvest handling techniques.

The purpose of this Protocol is to describe and explain the activities necessary for reducing post harvest losses, and for achieving the levels of consistent post harvest quality for peaches and nectarines required by EU and other international markets, and by regional high-value markets.

It is important to understand that post harvest handling of stone fruits or other crops cannot improve quality. The quality on the tree just prior to picking, is the best quality the fruit will ever have. However, good post harvest handling practices will ensure that perfect ‘just picked’ quality is maintained for the maximum possible length of time (three to six weeks depending on the variety), and losses will be reduced.

In order to maintain quality in a post harvest operation, there must be a system that monitor’s quality and alerts management that immediate action is required, if factors start to negatively affect quality and losses. This requires a monitoring Quality Assurance Program to be implemented. A short guide, “Implementing a Program of Quality Assurance” that explains the development and implementation of a quality assurance program can be found in Section 5 of this guide.

There is no one single step which will guarantee good post harvest quality - but many post harvest activities which are required to take a quality product from the field and deliver it to the consumer, with minimal losses or damage.

In order for the system to be effective, all requirements must be fully and carefully implemented. There are no shortcuts.
2.0 Harvest Maturity

“Post harvest” as will be seen, is a slightly misleading term, because good post harvest handling starts with establishing the correct stage of fruit maturity before harvest begins.

The stage of fruit maturity at harvest greatly affects the quality of peaches and nectarines as they move through the post harvest and marketing system. Ensuring that fruit is harvested at the optimal stage of maturity will provide the best potential for long storage life, and maximize the possibility of achieving top quality fruit in store.

It is essential to understand that maturity and ripeness are two very different stages of a fruit’s life.

A. Mature Fruit is defined as fruit that has reached a point in it’s development when it becomes physiologically capable of ripening naturally on its own – even though the fruit is not yet ready to eat, it is sufficiently well developed that after harvest the fruit will soften and become juicy. However, unlike apples and pears, peaches and nectarines do not improve in sugar content after harvest.

Fruits harvested before they are mature will be small, they will never ripen properly – they will be sour, taste starchy, have poor color and tough texture, low sugars, lack variety flavor and be more susceptible to storage disorders.

For peaches and nectarines, the main physiological change indicating a fruit’s level of maturity is the fruit’s internal production of the plant hormone Ethylene (C2H4) - a naturally occurring hormone which triggers the cascade of biochemical reactions involved in ripening. Ethylene produced when the fruit reaches maturity causes fruit to ripen, ie to soften, produce volatile compounds (aroma and flavors), convert starch to sugars, develop skin color, and breakdown green chlorophyll.

Fruits, such as peaches and nectarines, which produce ethylene in their ripening process are called climacteric fruits. Once climacteric fruit have begun to ripen, the ripening process is impossible to stop. However, the process can be slowed considerably, for example by cooling the fruit.

B. Ripe Fruit Botanically, ripe fruit is fruit which is in a physiological state to disperse viable seeds. Gastronomically, we generally consider that ripe fruit is fruit which has reached its optimum eating qualities – usually juicy, with soft, sweet and aromatic flesh and good skin color.

There is absolutely no doubt that the best fruits for eating are those which have been allowed to ripen naturally - to sweeten and soften on the tree. Regrettably however, tree-ripened fruit are easily damaged during transport, and have a very short distribution/ marketing life.

Commercially, exporting large volumes of tree-ripened fruit is currently technically impossible – fruit will be damaged and quality lost before the products can be delivered to end consumers.

As it is not possible to deliver ripe fruit to market in good condition, it is necessary to deliver mature fruit to market – fruit which is robust enough that it will store well during transport and distribution, and which will definitely ripen when it reaches the end consumer.
Indicators of maturity vary with variety, the following should be considered:

a) **Size and Shape**

Size and shape by themselves are not reliable indicators of fruit maturity. At best, they should be considered as a reason to investigate factors that give a better determination of maturity.

Some growers have observed that smaller fruit on the outside of a tree canopy have longer marketing/shelf-lives than larger fruit inside the canopy. This does not mean that fruit should be harvested when they are small. However, producers should experiment - it may be found that fruits from the outer canopy of their trees will have longer marketing lives and can be selectively picked for sales in more distant markets.

b) **Color**

Most varieties of peaches and nectarines achieve the pink or red blush on their skin early in their development. How much color they develop, or at what stage of growth they develop their pink or red color, is affected by the variety and by the level of exposure to light. Pink or red blush are therefore not good indicators of maturity.

However, the “base” color of the fruit changes as the fruit matures:

- from green to light green, or yellow in yellow-fleshed varieties
- from green to whitish-green, creamy white or cream in white-fleshed varieties.

Never pick peaches with a green undercolor since they will not ripen well. They will shrivel, become flabby and never achieve a good flavor.

c) **Stone Separation**

The separation of the stone from the flesh of the peach or nectarine is an indication of maturity, but is subjective and unreliable, principally because it is uncertain how long the stone has been separated.

d) **Firmness**

This is probably the best indicator of maturity in stone fruits. As the fruit matures the flesh becomes softer. Firmness of a typical sample of fruit is measured by a penetrometer, which measures the amount of force in pounds or kilograms required to penetrate the pulp of the fruit.

![Photograph 1: A Penetrometer used for measuring fruit firmness](image)

There are two problems with using firmness as an indicator of maturity:

i) It is “destructive,” that is, the fruit is damaged and cannot be marketed once the test has been made.

ii) Firmness can vary according to the size of the fruit and among varieties. Cultivation practices can cause variations within a variety. Fruit firmness is only a good indicator of maturity when used in conjunction with other indicators.

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1 Red skin color in peaches is a very important factor in the market. The consumer buys with his or her “eyes” and prefers peaches and nectarines to have good red color. Leaf tissue analysis (foliar analysis) can determine the nitrogen content in the leaves. If the level of nitrogen is 2.6 – 3.0%, the tree has the optimum level of nitrogen for good red color development and for maximum storage performance.
e) **Soluble Solids Content (SSC)**

Soluble Solids Content (SSC) is the amount of soluble material in the fruit juice, most of which is sugars. As the fruit ripens its starch content begins to change to sugar. The level of sugar in fruit can be measured by testing the juice with a refractometer\(^2\).

Photograph 2: Refractometer – Side view

Photograph 2: Refractometer – View from top

The range of SSC in a fruit generally correlates with the firmness of the fruit in determining maturity. Like firmness, cultivation practices and variety can affect and alter the relationship between maturity and SSC. Also like firmness testing, testing for SSC is destructive.

f) **Titratable Acidity (TA)**

All stone fruits contain acids. These acids decrease as the fruit matures. The change in acidity varies from one variety to another, but is considered to be more reliable than SSC. Firmness and SSC testing can be carried out in the field. Testing for titratable acids is done in a simple laboratory.

Table 1 shows the ranges of flesh firmness, soluble solids content (SSC) and titratable acidity (TA) in relation to maturity at harvest of stone fruits.

**Table 1: Indicators of Stone Fruit Maturity**

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Maturity Stage*</th>
<th>Firmness (lbf)</th>
<th>SSC (%)</th>
<th>TA (% malic acid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nectarine</td>
<td>1</td>
<td>13-15</td>
<td>8-9</td>
<td>0.9-1.1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10-12</td>
<td>9-10</td>
<td>0.6-0.8</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6-10</td>
<td>11-14</td>
<td>0.4-0.6</td>
</tr>
<tr>
<td>Peach</td>
<td>1</td>
<td>13-15</td>
<td>8-9</td>
<td>0.7-0.9</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10-13</td>
<td>9-11</td>
<td>0.5-0.7</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7-10</td>
<td>11-14</td>
<td>0.4-0.5</td>
</tr>
<tr>
<td>Plum</td>
<td>1</td>
<td>8-10</td>
<td>9-11</td>
<td>0.8-1.5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6-8</td>
<td>11-12</td>
<td>0.6-1.0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3-6</td>
<td>13-16</td>
<td>0.4-0.8</td>
</tr>
</tbody>
</table>

* 1 = partially mature; 2 = mature; 3 = partially ripe.

### 3.0 Harvest Operations

#### 3.1 Harvesting

**Harvest Maturity:** It is essential that harvested fruits should be of correct and uniform maturity, and that they are handled gently. All workers must be fully trained and understand maturity requirements, and picking crews must be constantly supervised to assure that fruit of correct and uniform maturity is being harvested.

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\(^2\) See Appendix 1: for guidelines on how to use a refractometer:
Stone fruits do not mature uniformly on all parts of the tree. Supervisors should be certain that all pickers know from which part of the tree they should concentrate their picking. This will vary with varieties and may vary within an orchard.

Since the fruit does not ripen uniformly on a tree, it is necessary to pick from a tree several times. In general, trees are picked 3 – 4 times at 2 – 3 day intervals. Again, this varies with climate, cultivation techniques, varieties, etc., but the supervisor must learn when to return to a tree to resume harvest.

**Harvest Care:**

Fruit must be picked and handled very carefully. Damage to fruit may not be apparent at the moment of mishandling, but it will appear as damage in the market.

![Fruit that is accidentally mishandled or dropped SHOULD NOT BE PACKED](image)

One of the hardest changes to implement on a farm is not packing fruit which has been accidentally mishandled, damaged or dropped. Managers want to sell fruit, pickers want to cover their mistakes.

However, packing damaged fruit (even if the damage is not immediate visible) will reduce the value of the total product consignment, and harm the grower’s reputation and ability to sell fruit in high value markets.

A company culture should be encouraged by managers:

**Dropped fruit is:**

- bruised fruit (even if the bruise isn’t yet visible)
- non-marketable fruit

If manager’s have any doubts of this, they should carry out experiments – ideally shared with staff.

Any fruit dropped should be put on public display and examined over 3-7 days, to determine how much bruising was caused by the fall.

The results of such trials should clearly demonstrate two criteria:

- Dropped fruit is unmarketable and should not be packed
- Staff must be encouraged to take more care, and should be given equipment and support to help them pick better with less accidents/damage occurring.

**Other Considerations for good harvesting:**

- Trees should have open canopies (to encourage good fruit color and inhibit disease development), but also to allow pickers easy access to pick fruit.
- Pickers should have clean hands – facilities must be provided for them to wash their hands during the day to prevent the spread of fruit disease spores.
- Pickers should not have long fingernails that might puncture the fruit, nor should they wear any rings that might damage the fruit (simple wedding bands are allowed). Any damage to fruit
reduces its quality and creates an entry for fungal rots - most disease-causing fungi enter fruit through a wound. If there are no wounds, rots will be significantly reduced.

- Harvesting staff should be provided with lightweight ladders, if necessary, to help them reach high fruit. Allowing staff to climb trees will result in poor harvesting, bruised fruits, and damage to trees and developing fruit buds for the following years fruit.

- After picking, fruit should be placed into a harvesting container, designed to reduce damage. Ideally staff should be provided with specially designed picking sacks with rigid sides and soft bases, which protect fruit from damage. Picking sacks which have wide shoulder straps, leave workers with both hands free, resulting in better picking and less worker tiredness. Tired workers cannot be efficient workers.

- Using soft containers, such as cloth bags or picking sacks, allows the fruit to be compressed against one another, causing damage to the fruit.

- Where specifically designed picking sacks are not available, plastic buckets which are smooth on the inside can be used, but these should be lined on the base with circles of impact absorbing material – dense plastic or rubber foam material, or plastic bubble wrap.

- All picking bags, pads and buckets must be kept clean and sanitized to prevent the build up of disease/fungal spores which will infect and rot the fruit.

- The fruit should be handled gently, never dropped into containers – supervisors should see pickers hands’ entering picking containers, as fruit is placed in the containers, and not dropped into them, to avoid bruising. There should be no sound of fruit falling or moving in containers.

- Likewise, when fruit is removed from picking containers to bulk bins, care must be taken to gently roll the fruit into the bulk bins – soundlessly and with no dropping of any sort.

- Staff must be trained not to harvest poor quality, damaged and especially rotting fruit at the same time as good fruit; it is vital not to contaminate good quality fruit with disease spores from rotting fruit.

- If fruit receive a great deal of rainfall just prior to harvest the fruit swells and is not as resistant to handling and mechanical injury. Injured areas will dehydrate during cool storage and will be seen as discolored areas on the peel. Pay attention to weather forecasts prior to harvest. If heavy rains are predicted, pick a little early, to minimize the adverse effect of excess rain.

- Diseased fruit should not be sent to the packing area. Fungi that cause disease will spread from one fruit to another and the decay they produce will appear after packing.

- If diseased or rotted fruit is handled, the picker must wash his or her hands prior to picking good fruit for packing. Fungal spores on the hands of the picker will easily transfer to good fruit and may cause decay during transportation or in the market – reducing the financial returns to the grower.

- Diseased fruit or poor quality fruit should not be left in the field – it will be a source of fungal contamination for future crops. It should be removed by a separate harvesting team, and disposed of.
3.2 Transport to Packing Area

Fruit should be handled carefully at all times - rough handling during loading/unloading and transport causes damage to fruit that may not appear until after the fruit has left the farm, but the effects – reduced sales and low sales prices will affect the prices paid to growers and the business relationship between the producer and buyers.

- Harvested fruit must be moved as quickly as possible from the field to the packing shed.
- Any delays shorten the marketing life of the fruit.
- Fruit left in the sun will very quickly sunburn – reducing both quality and weight of fruit. On a good farm, at no time should fruit be left exposed to sunshine; it should be stored, loosely covered with white washable covers, in the shade of trees, or ideally under a temporary shade net area erected during the picking season.
- Containers used to carry fruit must be clean and smooth on the inside to prevent abrasion.
- Movement of fruit as a result of bouncing, jarring and vibration during transport, is one the most common reasons for damage to the fruit. Trucks, wagons or trailers used for transporting fruit must move carefully and slowly, with, perhaps, a reduction in air pressure in the tires.
- Roads from the field to the packing area should be smooth in order to minimize the amount of jarring, bouncing and vibration that can cause damage to the fruit.
- Containers of fruit should be covered during transport with clean, lightweight, white covers to prevent sunburn and contamination by dust borne disease spores. Some growers use special lightweight pads, (eg of white polystyrene) securely held in place, which also help fruit minimize movement in the bins.
- Staff should never be allowed to sit, stand, rest upon/lean against, stacked cartons or bins of fruit; neither must they store personal belongings or equipment in or on bins or cartons of fruits.

When fruit in bulk containers is being transported to the packing area, the principle problem that occurs is vibration - small, but fast and very damaging movement of the fruits against one another and/or against the sides of the container holding the fruit. Any such vibration causes abrasion - visible damage to the skin of the fruit (down-grading its appearance and value), and when the vibration is severe, the fruit can be bruised.

For this reason, bulk containers used to carry fruit to the packing area, should be smooth on the inside. Wooden containers can be lined with “bubble pack” or plastic or rubber foam to reduce abrasion and wounds which can allow fungal rots to develop. Some producers line crates with disposable/one-use cardboard inserts designed to reduce friction against the interior sides Ventilation holes of bins used when pre-cooling or cooling fruit must not be blocked and the design of the liners must allow free air flow through bulk bins for cooling. In all cases, field bins and liners must be either new or sanitized prior to use to prevent the build up of fungal disease spores and spread of rotting disease.

3.3 Field Packing

If packing is carried out in the field, a shaded area should be provided to protect the workers and the fruit from the sun. The area should also be free of dust from moving vehicles. Dust on fruit lowers the quality, increases the possibility of abrasion damage and contaminates fruit with disease spores.
Fruit can be packed from bulk bins, or more ideally directly from picking containers into the final carton\(^3\). Excessive handling of the fruit causes damage to the fruit. Every handling or movement of the fruit that can be eliminated, should be eliminated.

Delays in cooling fruit result in a loss of shelf or market-life – ie the length of time the fruit remains in good condition. Packed fruit should be moved as quickly as possible to the cooling facility to ensure the best quality and the longest marketing/sales period.

### 4.0 Packhouse Operations

Packing operations range in size from very simple systems where one person carries out all the packing functions of sorting, sizing and packing, to the sophisticated, high technology systems that electronically sort size and pack.

### 4.1 Sorting

Sorting is the removal of fruit that is not suitable for packing. This fruit may be rejected for defects or for size, color or other factors. If a fruit is rejected because of cuts/rots or any type of physical damage, it is lost and may only be used for juicing, jam or cattle feed. Fruit that is not physically damaged, but is small, poorly shaped or with marks on the skin, may be suitable for less demanding lower value local markets, rather than higher value local or export markets.

Where large volumes of fruit are handled and there is a conveyor system for sorting, some producers also install a pre-sorting inspection. Pre-sorting removes fruit with serious defects that is only suitable for processing. Pre-sorting saves time by allowing sorters to concentrate on removing fruit with less obvious defects, and sort other fruit into their relevant quality grades – size, color, freedom from blemishes etc.

There are certain requirements to ensure good sorting:
- Lighting must be good so workers can easily see fruit defects.
- Workers must be able to easily and comfortably reach fruit and move it to the relevant grade container or conveyor.
- To reduce fatigue, workers should have a heavy rubber mat or wooden platform to stand on. Standing for long periods on cold concrete (or soil in the field) is extremely tiring. And tired workers cannot work well.
- If product moves along a conveyor it must move at a uniform speed that allows the workers time to sort, but not slow down the operation. Fruit should be rolling on the conveyor so the sorters can see all sides of the fruit.
- Staff carrying out sorting should be well supervised.
- If sorting is done by “eye” the sorters must be well trained, and the size of the fruit in the cartons must always be correct and consistent.

If fruit is sized by machine, care should be taken to ensure that:
- The line is well designed to prevent fruit touching - bruising and abrasion occur very easily by fruit bumping into other fruit or against parts of the sorting line.

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\(^3\) Harvesters place full picking containers at packing stations, or on trailers which are then transported to packing stations; after placing a full picking container, harvesters take an empty picking container, and continue harvesting.
Falls from one level to another should be avoided – fruit should move up or down gentle gradients. Where falls are unavoidable, surfaces should be lined with washable materials.

Damage to fruit may not be apparent at the moment of mishandling, but appears as damage in the market. Any fruit that is accidentally mishandled or dropped should not be packed.

4.2 Fruit Sizing

In international markets, size is a very important quality characteristic and one which must be a major concern to Moldovan growers. The following information is from legally enforced EU Marketing Standards (formerly known as Quality Standards) for peaches and nectarines.

- Peach sizes are determined by diameter and circumference.
- The diameter is measured at the equatorial section, measuring the narrowest diameter. This measurement is made with a fixed or vernier caliper.
- The circumference is measured using sizing rings.
- Peaches and Nectarines must be graded according to the following EU scale:

<table>
<thead>
<tr>
<th>DIAMETER</th>
<th>SIZING CODE</th>
<th>CIRCUMFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 mm and above</td>
<td>AAAA</td>
<td>28 cm and above</td>
</tr>
<tr>
<td>80 mm and over but under 90 mm</td>
<td>AAA</td>
<td>25 cm and over but under 28 cm</td>
</tr>
<tr>
<td>73 mm and over but under 80 mm</td>
<td>AA</td>
<td>23 cm and over but under 25 cm</td>
</tr>
<tr>
<td>67 mm and over but under 73 mm</td>
<td>A</td>
<td>21 cm and over but under 23 cm</td>
</tr>
<tr>
<td>61 mm and over but under 67 mm</td>
<td>B</td>
<td>19 cm and over but under 21 cm</td>
</tr>
<tr>
<td>56 mm and over but under 61 mm</td>
<td>C</td>
<td>17.5 cm and over but under 19 cm</td>
</tr>
<tr>
<td>51 mm and over but under 56 mm</td>
<td>D</td>
<td>16 cm and over but under 17.5 cm</td>
</tr>
</tbody>
</table>

Notes:

i. The minimum size allowed for “Extra” class is 17.5 cm (circumference) or 56 mm diameter.

ii. Size D (51 - 56 mm in diameter, or 16 - 17.5 cm in circumference), is not allowed in the period from 1 July to 31 October.

International markets generally prefer the largest sizes of fruit and, if Moldovan producers are to participate in the high-value international markets, the size of the fruit produced must be larger. With the help of local Moldovan university and extension personnel, proper fruit thinning techniques can be developed to increase the size of fruit produced to meet the international standards.

\[\text{Surfaces must be fully washable to allow cleaning and sanitation.}\]
Fruit sizing is carried out for the following purposes:

- To standardize sizes for the marketplace. In the language of the market everyone understands what is meant when someone talks of a specific size, such as “AAA.”
- This makes communication between the buyer and seller easier and settles any disputes that may arise about size.
- When fruits are of a uniform size and properly packed in the correct sized cell trays/liners and cartons, they are stabilized, that is, they do not move and damage is effectively eliminated. Movement of fruit in a container during transit or handling can seriously damage the fruit – downgrading it’s quality, class classification and value.
- Different markets require different sizes. In general, international markets demand large fruit. Regional markets expect and accept medium-sized fruit. Local market are an outlet for small fruit.
- When shipping to an international market it is legally necessary to have the correct size fruit in the carton. If a carton is labeled with fruit size “AA,” the fruit inside must be of AA size or there will be a rejection, a reduced or zero price paid to the grower, and the very real possibility of the importer being prosecuted and fined by market inspectors in the importing country. In addition to the almost certain loss of a customer/importer/buyer, the reputation of the grower and, perhaps the reputation of the country of origin of the fruit, will be damaged, making it doubly hard to enter and participate in new markets.

The size grading of fruit can be carried by:

- By “eye” with trained, experienced workers using simple, plastic sizing rings.
- By machine. One simple machine is the “roller sizer.” This grading or sizing equipment moves the fruit over rollers that have increasingly wider spaces between them. When the space between two rollers is sufficiently wide, the fruit passes between them, and moves to a padded packing table.
- Another type of size grader is a “belt grader”. On a belt grader the fruit flows onto a belt with holes of certain size. Fruit that is too large to pass through the holes in the belt to a packing table below, move onto another belt with slightly larger holes, and so on, until the fruit arrives at a belt through which it can pass onto a packing table for its correct size grade.
- Large commercial operations use far more efficient and accurate “volumetric graders”. These place fruits in individual cups and moves them along a fast moving conveyor, the cups electronically sense the weight of the fruit, and unload it at the appropriate packing point. Sizing peaches and nectarines by weight is possible because size is directly correlated with weight.
- Good volumetric graders are extremely expensive, and are usually shared by growers in a marketing co-operative, or are sometimes purchased by very large growers, who grade and market fruit for other growers. Because of their high cost, these graders must be used to the maximum – and after grading one crop, they can be calibrated to grade other similar sized fruits – such as apples or citrus fruits.

4.3 Package Design and Management

Packaging selected for use should be packaging that will best protect the fruit during transport, marketing and storage, and which provides optimum cooling ability. There are no financial benefits in purchasing and using inexpensive packaging if it does need meet the needs of the product. However, different packaging is frequently used for different buyers/quality of fruit supplied.
In general, packaging must be:

° Designed specifically for the product it will hold.
° Easily able to hold the required amount/weight/size of fruit - usually in a single layer - with absolutely no risk or danger that the container will be too small.
° Designed to fit precisely an international size pallet (size 100 x 120cm), without failing to cover the entire pallet and without overhanging the pallet edges.\(^5\)
° Strong enough to support the weight of packed cartons above it – absorbing and resisting compression forces through its side walls, and especially through corners and corner edges.
° Corrugated board (cardboard) used for cartons should be sufficiently strong, either three or five-ply thickness. It must be waterproofed to ensure that it does not weaken and collapse in moist environments, eg coldstores. Moisture proofing is usually accomplished by including a thin plastic coating to the board during manufacture.
° Containers must be designed to have a certain stacking strength when vertically stacked. Some may only be stacked “corner on corner” directly one on top of another, while others are designed for “cross-stacking.”
° Proper alignment is important for maintaining the integrity of the packages. The carton should have simple ‘tabs’ included in the design, to ensure good carton alignment when they are stacked, and ensure maximum strength, stability and integrity of the stack.
° Cartons must be easy to assemble. To supply EU markets, the use of wooden trays and metal stables in cardboard containers should be avoided; any glues used must be food safe. It is recommended to use a well designed carton, which can be assembled quickly and by folding, rather than stapling or gluing.
° The cartons should display fruit, to facilitate inspection by buyers with minimum damage to the fruit and frustration to the inspector.
° Pack Ventilation: Stone fruit must be cooled as rapidly as possible after packing. If a package is poorly designed without adequate ventilation holes, cold air will not reach the product and the fruit will not be cooled well or quickly enough.
° Cartons should have ventilation holes that are adequate enough to allow good airflow through the carton. The ventilation holes/slots must be designed to ensure that when cartons are stacked the ventilation holes or slots are aligned, permitting efficient and fast airflow through every carton on the pallet, and therefore rapid cooling of fruit.
° The greater the amount of ventilation, the faster the product inside a carton will cool. However, too many ventilation holes will seriously weaken a carton’s strength, and render the packaging less effective/protective. The recommended amount of ventilation for a carton is approximately 5% of its surface area.
° Moisture Loss: All fruits (and vegetables) lose water while in cooling and/or storage or while transported to market. This loss of water is due to normal fruit respiration and also dehydration by air movement around the fruit. Loss of water from a product is a loss of money – directly as less fruit (kg) is available for sale, but also as a result of loss of quality – dehydrated fruit is not top quality fruit and does not result in top sales prices. Symptoms of this deterioration in stone fruits include shriveling and surface cracking, especially on nectarines.

For very high value fruit, and where a complete cold-chain (refrigerated system) exists from packing operation to customer shelf, simple moisture barriers are recommended to reduce dehydration. Many stone fruits that are shipped long distances to international markets are packed in retail size plastic boxes (eg 1kg capacity), or have a thin film of plastic (a moisture

\(^5\) Tray sizes for peaches are usually: 40 x 30cm, or 60 x 40cm (maximum exterior measurement)
barrier) placed loosely in the carton under the cell tray and over the top of the fruit. The film does not necessarily eliminate water loss, but greatly reduces it. However care must be taken to ensure that cooling is not slowed; moisture barriers must not be made of thick films, or block ventilation holes in cartons.

° Films should only be used where a complete and effective cold chain exists; if fruit is allowed to warm:
  o respiration rates will increase,
  o moisture will be lost from the fruits
  o moisture from fruits will be trapped inside the moisture barrier
  o warm conditions and high humidity will promote very rapid development of fungal rots.

° The film should not be too tightly packed or sealed over the fruit as some air circulation is essential around the fruit.

° It is highly recommended that plastic cell trays – of the correct size grade for the fruit to be packed - are used in cardboard or wooden boxes, to minimize fruit damage and loss during cooling, transport and marketing.

° Sometimes the market will request special packaging. An example of this is the use of small retail transparent plastic boxes (eg 1kg capacity) or film-wrapped\(^6\) small retail cell-trays for four or six fruit.

° All cartons or boxes are a company’s major marketing tool. They should be attractively designed and labeled, to catch the eye of buyers. Needless to say, attractive packaging must contain attractive, well graded and presented fruits to ensure buyer interest, and should carry the producer/exporter’s company name and contact information.

Photographs 4 – 10: Packaging

Peaches packed in fibre cell trays, in single layer cartons

Peaches packed in plastic cell trays, in single layer wooden trays

Nectarines packed in plastic cell trays, in single layer wooden trays

Nectarines packed in plastic cell trays; in single layer wooden trays – note corner supports on pallets and horizontal plastic pallet strapping (top layers of boxes have been removed from the pallet)

\(^6\)Stretch film is not used for wrapping trays for peaches as this will compress and damage the fruit. Loose covers of semi-permeable polypropylene are used.
Packaging Storage and Management

- Having designed, selected and purchased packaging at considerable expense, it is important than an organization takes care of the packaging. Packaging should be:
  - Stored off the floor (eg on pallets), in clean, dry, vermin/insect and bird proof stores.
  - If packaging is to be stored for more than a few days, it should be covered, to prevent it becoming soiled by dust etc.
  - Staff should treat packaging with respect to ensure it is not even slightly damaged – it is the company’s marketing tool, and the first thing that buyers see. If packaging has been badly handled – it will give a very bad impression to buyers.
  - Staff should not sit on, walk over, throw or mistreat packaging in any way.

Of course, management responsibility is greatest. Management should ensure that staff have training in packaging management, and the equipment and systems necessary to handle/move/stack packaging in optimum condition.

4.4 Product Assembly

Packed containers of fruit should be handled as carefully and as little as possible. Excessive handling of the containers of fruit will damage the fruit. Palletization helps minimize handling of containers and makes handling faster and easier.

Proper stacking on the pallet is crucial to maintaining the stacking strength of the cartons and ensuring that ventilation holes or slots for cooling are properly aligned.

During transportation to customers, the cartons on the loaded pallet must be stabilized. This is carried out by placing a heavy duty cardboard corner support at each of the four corners of the stack, and securely strapping the cartons horizontally around the stack of cartons with pallet straps and strapping equipment. The straps and corner boards hold the cartons aligned and immobile.

Where transport routes are rough (eg poor roads, sea journeys), straps are also placed around the pallet from top to bottom, to further stabilize the pallet of cartons. In these instances carton material must be folded over the top of the top cartons to protect the cartons and fruit from compression damage caused by the strapping.
4.5 Minimizing Mechanical Injury to Fruit

Mechanical damage includes:

a) Vibration Bruising

Vibration bruising is a distinctive type of bruising found mostly on the equatorial part of the fruit. This bruising is sometimes called “roller bruising” because the fruit is rolling in the carton and bumping against other fruits as it rolls. In addition to bruises around the center of the fruit, numerous small bruises can be found anywhere on the fruit.

As was elaborated earlier in this Guide, vibration bruising generally occurs as the result of fruit moving inside a carton or container while the container is being moved, in a packhouse, or in a vehicle carrying the fruit to market. This vibration always occurs when packed fruit is moved, sometimes to a greater degree. The vibration can be reduced by using vehicles with softer suspension systems, by reducing air pressure in tires, or by making farm roads smoother.

But the main prevention for vibration bruising is proper filling of cartons/containers. The containers should be full enough to ensure that the fruit does not move in the carton, but not over-filled. The best method for avoiding vibration bruising during transport to market is to pack fruit securely in cell trays/liners of the correct size for the fruit packed, so that the fruit does not move during transit.

The correct size packing materials must be used - if cells in “cell trays” are too large for the fruit packed, they will not prevent the fruit from moving and being damaged.

When cell trays are not used, cartons or boxes should not be under-filled or over-filled. Under-filled containers allow the fruit move, resulting in bruising. Over-filled containers cause the fruit to receive “compression bruising.”

b) Compression Bruising

Compression bruising is caused by something or someone putting too much pressure on the fruit. Typically compression bruising is seen as a flattened area on the surface of the fruit, however, the compression bruises may not be seen until some cuts or eats the fruit and finds the flesh is damaged beneath the skin. There are many ways to avoid compression damage, including:

i. Never over fill packages: Overfilling cartons or packages is a common cause of compression bruising. When a carton is overfilled and another filled carton is placed on top of it, the weight of the upper carton compresses the fruit in the carton below. If the carton is not overfilled, the weight of the upper carton is borne by the walls and corners of the lower carton.

ii. Do not place objects on top of fruit or containers of packed fruit: Commonly seen, inappropriate activities include:
   o Badly stacked cartons – cartons must be stacked corner to corner neatly, or correctly cross-stacked – if they are designed for cross-stacking.
   o Placing objects on top of fruits - occasionally, someone will put a heavy object on a carton or cartons and compress the product
   o One of the most distressful sights in a packing operation is to see someone sitting on a carton of fruit. The cartons are obviously not made to bear that weight, but it happens. Cartons are weakened by the excess weight, and are less able to resist compression forces later as they pass through the marketing chain.

7 Different types of cell trays/liners can be purchased – optimized for size and type of fruit (apple, peach, pear etc.) packed
iii. **Handling of packed cartons:**

- Never allow staff to throw or drop cartons of packed fruit. Throwing packed cartons – even short distances, eg whilst standing in line to fill lorries - will cause compression bruising, even if it is not immediately visible.
- Ideally, cartons/containers of peaches should never be carried manually; less damage occurs to fruits which are moved either on wheeled crate movers, or when stacked on pallets and moved with a pallet mover. This also has the advantage that packhouse staff become less tired, and therefore remain more efficient.

**c) Impact Bruising**

Impact bruising is any form of injury caused by some type of force hitting the individual fruit or carton of fruit.

- The most common way in which impact bruising occurs is by dropping fruit or a carton of fruit; (this risk can be minimized by ensuring that staff never throw or physically carry cartons of packed fruits).
- If peaches are dumped onto a wooden packing table without care, some amount of “impact damage” or light bruising will occur. If padding is added to the tables surface the damage resulting from the impact will be eliminated or reduced.
- Another common cause of impact injury is when fruit drops from one level to another on a packing line, or bumps into a protruding part of the packing line. Before a mechanized packing line is used for the first time, fruit\(^8\) should be run over it to check for any places where impacts may cause damage to the fruit. Ideally fruit should not drop from one level to another, but should pass down a well padded slope, or at a point of impact, a curtain of heavy plastic should be put in place to slow the momentum of the fruit, eg as it moves from a conveyor to a packing table.
- Injury may occur when a forklift truck hits a pallet of fruit, or when boxes are thrown or violently pushed into place while being loaded into a transport vehicle. Very often impact bruising is caused by carelessness and supervisors should be vigilant to prevent this type of injury.

**d. Staff Training**

Unfortunately, many people do understand how fragile fruits are, even when well packed. Training and constant supervision are critical to prevent damage and losses.

\(^8\) Or a computerized impact recording device check can be carried out. See ADP offices for this service.
4.6 Temperature Management

Fruits and vegetables are alive after harvest, however having been separated from the plant, they receive no nutrients or water. They continue to respire, taking in oxygen that combines with carbohydrates, proteins and fats to create energy (heat), carbon dioxide and water; the energy/heat produced is known as heat of respiration, and the overall effect is deterioration of fruit quality and salable dry weight.

Correct temperature management – cooling - is the single most important tool in reducing respiration and maintaining product quality and shelf-life. Correctly carried out, cooling:

- Removes field heat
- Slows down respiration
- Reduces heat of respiration
- Reduces water loss
- Slows product deterioration – extending the marketing life
- Slows ethylene production
- Limits the growth of decay organisms

a. Field Heat: Field heat is the temperature of the fruit as it comes from the field. Fruit arriving at the cooling facility may often have a pulp temperature higher than the ambient temperature. Pulp temperatures should be checked with a pulp. It is important that the tip of the thermometer probe be inserted completely into the fruit near the stone, left for a few seconds and then the reading should be taken.

b. Heat of Respiration It is neither possible or desirable to stop fruit respiration, but it is both desirable and possible to significantly reduced the rate. Holding fruit at its ideal temperature (-1.0°C to 0.0°C for peaches, plums and nectarines) greatly slows the rate of respiration, but does not stop it. At these storage temperatures, respiration continues and reduced levels of heat of respiration continue to be produced. After pre-cooling fruit, it must be held in a cold store with a refrigeration capacity that can remove heat of respiration.

c. Reducing Water Loss Water loss is a direct result of respiration. The higher the respiration rate, the greater the loss of water. Lowering the respiration rate lowers the loss of water (and weight) from the fruit, and increases the life and value of the fruit.

d. Product Deterioration The faster the respiration rate, the faster fruit food reserves are used. Loss of food reserves results in deterioration of fruits and loss of quality. Cooling slows respiration and hence deterioration.

e. Ethylene Production Ethylene (C2H4) Ethylene is a ripening and senescence plant hormone. It is a gas at normal temperatures and is physiologically active and causes ripening at concentrations as low as 0.1 ppm (The equivalent of 1 second in 115 days). Peaches are climacteric fruits – which means that once ethylene production has started, it cannot be stopped – it can only be slowed. Quickly cooling stone fruits to their ideal hold temperature will delay and/or slow the climacteric rise in ethylene production.

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9 Set temperatures in cold stores, even modern cold stores, fluctuate by +/- 2degrees centigrade; they are never exactly as set. It is recommended to set cold store temperatures at 2 degrees centigrade above the optimum temperature, in order that freezing of fruits does not occur as a result of temperature fluctuations.
f. Limiting Decay Organism Growth  Most decay causing fungi do not grow or sporulate at the temperatures recommended for storing or shipping stone fruits. The problem of decay is not eliminated, but it is greatly reduced when the product is quickly brought to its ideal temperature and held there.

4.7 Cooling Systems

Fruit should be cooled as rapidly as possible after being packed, each hour of delay in cooling reduces marketing life. When fruit cannot be packed the same day it is picked, it should be pre-cooled on the day of harvest, placed in a cold store and packed quickly the following day.

There are many systems for pre-cooling fruits and vegetables including:

a. Room Cooling

In room cooling the product is placed in a cold room and the heat is removed by convection. Some produce is still cooled this way but it is not acceptable for the cooling needs of most produce. Room cooling is a very slow process that can take from 20 – 100 hours to complete. During the time taken to cool, the fruit still respires and deteriorates at a fast rate.

The cold room can be made slightly more effective if the pallets are stacked widely spaced to allow good airflow, or by installing fans for increased air circulation.

b. Forced-air cooling

Forced air cooling is the most popular form of cooling for most fruits and vegetables, and is certainly the preferred choice for stone fruits including peaches and nectarines.

Forced air systems function by forcing cold air to circulate through containers and over fruit, removing the heat as it flows by. Cooling can be completed in 1 – 10 hours, depending on the refrigeration capacity of the system, and the fruit temperature when it arrives at the pre-cooler. The rapid cooling greatly diminishes the rate of respiration and product deterioration. It also makes managing a cold store/packing house easier and more efficient.

There are various forced-air systems, but the ones most used are those which pull cooled air through containers of fruits and vegetables. Systems are either mobile, or permanent fixed systems.

i. Mobile Forced-air Systems

Mobile forced-air systems are used in cold rooms to hasten the cooling of product. A simple system involves:
- placing cartons or bins of fruit in a line, in cold store,
- covering the top and ‘long’ sides of the line with a heavy duty plastic cover to form a tunnel;
- placing a freestanding, purpose built fan near one open end of the ‘tunnel’ positioned to create a negative pressure and drawing cold air through the ‘tunnel’ of fruit, cooling the fruit. (Note: a negative air flow must be used – cold air must be drawn through products into the fan; attempting to force fans to blow cold air into the fruit (positive pressure) results in very uneven cooling).
A more complex system involves pallets or bins of fruit, stacked in two rows with a gap between the rows. The space between the pallets, called a “tunnel” is covered by a “row cover” usually made of canvas or heavy duty plastic, and sometimes reinforced/strengthened with slats sewn into the material from side to side, (about every 0.5m), to prevent the row cover collapsing into the tunnel.

Care must be taken to ensure:
- that pallets are placed side by side, with no air spaces between pallets, or containers on pallets.
- the cover is correctly placed over the tunnel.
- the ventilation holes on cartons stacked on a pallet are aligned so air will flow through the stacks, and around the fruit, thus removing heat from the fruit. If the flow of air prevented from passing over the fruit, cooling will be slow or ineffective.

A fan is placed at the open end of the tunnel which pulls the air out of the tunnel, creating a negative pressure, and pulling cold air from the room through the packs of fruit, to the tunnel and then to the fan. As the cold air passes through the containers it removes heat from the fruit.

ii. Permanent Forced Air Cooling Systems

A permanent system involves including a false wall\(^{10}\) in the cold store, with a fan behind the false wall, and one or more openings in the wall. Boxes of fruit are lined up closely in two rows, one on either side of an opening in the false wall. A plastic or heavy cotton tarpaulin is placed over the gap between the two rows, and down to the floor at the end of the rows furthest from the wall. The fan pulls cold air from the room through the boxes of fruit and into the opening in the false wall; the air then passes through the fan and is recycled into the cold store.

Photographs 11 and 12: Pre-Coolers, before and after loading

\(^{10}\) These false walls are known as plenum walls.
A stacked permanent pre-cooler showing:

- Two lines of packed fruit stacked on pallets are arranged close to the wall, one on either side of an opening in the false wall.
- A cover is placed over the top of the two lines of cartons, over the gap between rows, and at the end of the rows furthest from the wall. The fan pulls cold air from the room through ventilation holes in the cartons, around fruit, into the gap in the false wall, and out through the fan vents above.

Air flow is basically lazy. It will not flow over (and thus cool) products in bins/cartons if it is allowed to flow through open air spaces between pallets/bins/cartons, or even underneath pallets. All these air spaces – short cuts or pathways which allow air to by-pass the products to be cooled - must be blocked, eg by stacking bins or cartons closely/tightly side by side, by covering with the row cover, and in the case of pallets, by blocking air spaces with strips of cardboard.

In the tunnel, the greatest negative pressure is near the fan. The pressure is least in the pallets farthest from the fan, and the fruit farthest from the fan is therefore that which cools most slowly. Fruit pulp temperature is monitored by placing a thermometer probe into a fruit in the top middle of the last pallet, and monitoring it to see when it reaches the required pulp temperature, at which time the fruits should be immediately removed from the forced-air cooling system.

Forced-air cooling, like any dry cooling, removes some moisture from the product. For this reason fruit must not be left in a cold air current any longer than necessary. Maintaining the optimum relative humidity (RH) in the both the pre-cooler and cold store, 90 - 95% for peaches and nectarines, is important for minimizing dehydration, product weight loss and quality loss.

Forced Air Refrigeration Equipment

Correctly designed and managed, a pre-cooler reduces cooling times and increases the storage life of fresh fruits and vegetables very significantly, provided the equipment purchased is suitable for the intended cooling.

The forced air fan, for example, must have the required airflow, measured in cubic feet per minute, (cfm) and static pressure.

The volume of airflow depends largely on the amount of fruit that is being cooled at any one time. Some fans are adjustable for airflow, but most have a single speed. The fan may be an axial-flow fan or a centrifugal-flow fan. Most cooling systems use an axial-flow fan.

The pressure created, when a fan pulls an airflow against the resistance of a stack of containers, reduces the effectiveness of an ordinary industrial fan to almost nothing. The static pressure of a fan is a specification, measured in inches of mercury, that indicates the ability of the fan to respond to pressure exerted against it. Fan specifications are based mainly on the volume of fruit to be cooled and the time available to cool it. In general, the size of fan needed for most small and
medium-sized farm cooling operations is one with 5,000 to 6,000 cfm and a static pressure of ½ or ¾ inches.

**Refrigeration system.** Most people agree that you can never have too much refrigeration or cooling capacity in a pre-cooler, because of the enormous amount of refrigeration required at the beginning of cooling. However, refrigeration equipment is expensive and a balance must be struck between desirable refrigeration capacity and cost.

Forced-air cooling moves more air faster, and removes more heat faster, than room cooling. To ensure that there is sufficient refrigeration capacity to cool air quickly in the pre-cooler, the capacity of the pre-cooler refrigeration unit will be higher than a refrigeration unit designed for a simple cold store.

Calculations of required refrigeration capacity and equipment are highly technical. In order to maximize returns on investment and ensure cost effective cooling, each system must be individually designed for the type and quantity of product to be cooled. However, a broad guide on refrigeration capacity required for forced air cooling is attached at Appendix 1. It is not the detailed and highly specific technical calculation a refrigeration engineer would make, but it has proven to be, and is intended as, a reliable general guide.

**Humidification Systems.** Cooling removes moisture from the product being cooled. To prevent excessive loss of moisture from the product the air in the cooling or storage room should be kept at 90 – 95% relative humidity. This means supplementing the moisture in the room with a humidifying system.

c. **Hydro-cooling**

Hydro-cooling is an old-fashioned method of cooling fruit used in the US, and is the most rapid. Water is an excellent cooling substrate. Cold water is flushed through bins of fruit that arrive from the fields, removing field heat immediately.

However a commercial hydro cooler can cost hundreds of thousands of dollars. The refrigeration system required for a hydro-cooler must be capable of quickly cooling large quantities of water and fruit to zero degrees centigrade.

In addition to a good cooling system, a good source of safe, potable water is required, and an effective water sterilization system. It is essential that diseases from one fruit are not spread to all the fruit in the batch via the cooling water. The water sterilization system must therefore be carefully managed, preferably computer controlled, and capable of automatically monitoring and maintaining sterilants at effective levels.

After hydro-cooling, fruits are generally dried with a combination of special rollers and cold air currents.

d. **Package Icing**

Some products can tolerate water-ice contact. The ice may be finely crushed and put over the product before loading into a shipping unit or top-iced after it has been loaded. Other times ice slurry or “liquid ice” is applied around loads of field packed products. As with hydro-cooling,
significant refrigeration capacity it required, together with potable water and effective sterilants to prevent the spread of fruit rots.

This is not a cooling method recommended for stonefruits.

e. **Vacuum cooling**

Vacuum cooling is a method of cooling used primarily for leafy vegetables, mushrooms and other products that have a high surface area to volume ratio. Produce is loaded into an extremely strong, air-tight steel chamber called a vacuum tube. Air is pumped out reducing the atmospheric pressure in the tube. This causes a small amount of water in the fruit to vaporize. The heat energy for vaporization comes from the product, and results in cooled fruit. Vacuum coolers are available in different sizes, from two-pallet up to six pallet size; costs are extremely high, around US$50,000 for a two-pallet size cooler, plus the same amount again for transport and installation. After cooling in a vacuum cooler, products must be stored in a cold store (they cannot be stored in the vacuum cooler).

This is not a cooling method recommended for stonefruits.

**4.8 Stone Fruit Storage**

The storage life of peaches varies by variety, from 1 – 7 weeks, and care must be taken not to mix or confuse varieties of short storage life with those of a longer storage life. If peaches are held beyond their maximum storage life, they will begin to breakdown internally and be unacceptable for the market.

Temperature maintenance is critical to maximize storage life. The fruit should be quickly pre-cooled and then held at it’s ideal temperature of -1.0 °- 0.0°C and 90 -95% relative humidity. Airflow during storage must be sufficient to continually remove the heat of respiration. Care should be taken to stack the pallets in a way not to obstruct airflow, or divert it away from fruits. Pallets should be stacked at minimum 25cm away from any walls, packaging/bins should have adequate ventilation holes, and there should be no other obstructions to airflow.

One of the most frequent complaints by consumers and wholesalers is lack of juiciness (flesh mealiness), flesh browning, black pit cavity, flesh translucency, red pigment accumulation (bleeding), and loss of flavor in peaches. These symptoms are caused by a genetic disorder, and are triggered when fruit is exposed to low temperatures; therefore the condition is known as chilling injury. In the specific case of peach, the expression of chilling injury is also called internal breakdown.

Research at the University of California has revealed that many mid-season and late-peach cultivars are susceptible to chilling injury or internal breakdown. Chilling injury symptoms develop faster and more intensely when fruit are stored at temperatures between circa. 2.2 degrees centigrade and 7.6 degrees centigrade (36 degrees Fahrenheit and 45 degrees Fahrenheit than those stored at 0 degrees centigrade (32 degrees Fahrenheit) or below.

Stone fruits can be stored in controlled atmosphere (CA) storage, but this is not done commercially. The recommended atmosphere for CA storage is 1 -2% O₂ + 3.5% CO₂.
4.9 Transport and Distribution

Fruit that is pre-cooled before packing should be pre-cooled again before shipping or storage. During the packing process the fruit will lose some of its coolness and must be quickly re-cooled.

Lorries (or marine containers) must be cleaned prior to loading fruit into them, as residues from previous loads may harm the fruit or leave undesirable residues on the fruit or containers.

The producer/packer should check that vehicles are in good condition. Damage to interior walls or doors that seal poorly can cause a loss of cooling, resulting in over-heating and deterioration of the fruit during transport.

Vehicles must be pre-cooled before fruit is placed into them. During the time taken to cool a vehicle that is not pre-cooled, loaded fruit will become warm. Refrigeration units of a vehicle or marine container are not sufficient for rapid cooling, - they are designed only to maintain the temperature of fruits/vegetables stored.

Not all drivers know the required temperature of the fruit during transport. The farm/packer manager should personally check and record the refrigeration units thermostat setting to ensure that it is correct.

Many companies use disposable or re-usable temperature recorders to record temperatures during transport of products to export markets. The temperature records are used if, after delivery, it is suspected that goods have not been transported at the correct temperature. The use of temperature recorders requires a good working relationship with buyers – who are requested to retrieve the recorders and relay the records when consignments are received.

The placement of pallets in the trailer or container must allow for good airflow, as the heat of respiration produced by the fruit cannot be effectively removed if the airflow does not move over and through all of the cartons of fruit on the pallets.

4.10 Packhouse Sanitation

It is not the intention of this guide to set out sanitation systems for packhouses. The ADP Project has produced two guides to Food Safety Practices – A guide to HACCP implementation and a Guide to Basic Programs required for HACCP Implementation, and the reader is recommended to read and consider them.

However, it is important to note that:

- the area in and around the packing area must be kept clean and free of refuse and waste, to ensure that any risk to produce of contamination by decay organisms is eliminated. This can only be done by implementing efficient and effective cleaning and sanitation programs.
- Workers must exercise good personal hygienic practices, and management must provide adequate facilities for this. Food-borne illnesses result from poor hygienic practices. If the fruit from a single company causes illnesses, the company and all those in the local industry may be banned from the market.
5.0 QUALITY ASSURANCE

5.1 What Is Quality?
This is a simple question with a complex answer. Quality means different things to different people. Some of the ways in which the term Quality is used in reference to fresh fruit and vegetables are:

Production Quality: This refers to the results a grower gets from his production. One variety may have better quality because it produces more yield, another because it is more resistant to disease and yet another, because it has better color, etc.

Market Quality: The wholesaler or retailer might prefer one variety over another because of their customers’ preference for a certain size, shape, flavour or other factors, including resistance to transport damage and length of shelf/market life.

Shipping Quality: This refers to how well different fruit and vegetable varieties resist damage during shipping (transport).

Edible Quality: This is a Quality everyone is interested in, and one about which everyone has their own opinion. Is one variety sweeter than another? Is another more acid? Are there too many fibers in another? Is the aroma of one better than others? It is all a matter of personal taste and, it varies hugely from country to country and even between regions in a country.

Table Quality: Also known as “consumer quality,” this is the quality the consumer expects to pay for, and like edible quality varies from country to country. Very often the only quality differences are those that appeal to the eye. The consumer likes to see a “pretty” piece of fruit or vegetable. Characteristics to be considered include: fruit size, shape, color, fragrance, uniformity etc.

Nutritional Quality: Increasingly consumers are concerned about the nutritional benefits of the foods they eat. Fruits and vegetables are constantly being evaluated for their vitamin, mineral and carbohydrate contents. Freedom from contamination by pesticides is an important part of this requirement.

Processing Quality: This is usually applied to produce that does not meet market quality levels. It also means those varieties with good internal quality that best lend themselves to processing operations.

There are many ideas about what constitutes quality. For the grower/exporter, the main concern is the market and the Quality perceived by his chosen market to be the best Quality.

5.2 The Role Of Standardization
The industrialized nations of the world have developed and implemented standardization as a means of describing and legally enforcing quality levels of fresh produce.

A program of Standards, whether national or client driven, is considered an asset because it allows the measurement of quality and assists growers, shippers, importers, wholesalers and retailers in
their commercial dealings. Clearly defined standards act as an incentive – everyone wants to produce or buy Class 1 products – or better - and helps settle disputes between buyers.

In the EU, Marketing Standards (formerly they were known as Quality standards) set out required characteristics, plus the type and maximum levels (tolerances) of quality defects permitted. Products failing to meet the standards, or products incorrectly labeled with the Quality Grade or Class, cannot be sold in the EU. A summary of EU standards can be found at Appendix 3.

Standards – whether national, or client standards – should form the basis of the development of an in-house quality assurance program.

5.3 Development Of A Quality Assurance Program

Markets are increasingly demanding consistently high quality fruits. Failure to maintain high quality may mean:

° a lower price for the product or loss of the shipment
° the inability to enter new markets
° the loss of existing markets.

And quality must be standard and consistent - if the product quality of a producer/exporter is not reliable that producer/exporter will very likely lose customers and develop a poor reputation in the industry.

IN INDUSTRIALISED COUNTRIES, THE VAST MAJORITY (85% PLUS) OF WHOLESALE FRUIT AND VEGETABLE SALES ARE REPEAT ORDERS – THE RESULT OF STRONG TRADING RELATIONSHIPS AND AGREEMENTS BETWEEN BUYERS AND SUPPLIERS

Quality assurance and quality control programs provide the producer with the means of maintaining a cost-effective level of quality.

Briefly:

Quality assurance can be briefly described as a program which monitors, evaluates and documents the production system from field to market, with the objective of assuring that the system cost-effectively produces the quality required.

Quality control is the individual activities needed to make an evaluation at any point in the system, and the actions taken to make any necessary adjustments in that system.

One of the first considerations is where the peaches will be marketed. This will be determined by market demand, price, available transportation, etc. If market research indicates that the chosen market is likely to be both accessible and profitable, the next step is to determine what quality characteristics the market demands.

There are various ways to make this determination. It may be from visual inspection of peaches in the market, from national standards, if they exist, or from communication with the buyer. The best method would be a combination of all these. If standards exist they should be consulted and studied first and their definitions well understood.
This should then be complemented by a visual inspection of the peaches in the intended market, to see how the peaches at any given quality level compare with the written standards for quality, and to determine whether the producer is able to produce and deliver similar, or better quality products.

Most national standards – including EU standards, have tolerances (permitted levels) for specific defects. However for export crops, almost all importers work only to the highest classes – Class 1 and above. And importers frequently set:

**A ZERO TOLERANCE FOR DEFECTS**

The reason for this is the high cost of transport. It is uneconomical to transport a consignment for hundreds of miles or more, only to sell 10% of the consignment for low 2nd quality prices – which do not cover production plus transportation costs, or even worse to throw them away because they are non marketable in markets that only buy top class products.

5.4 Establishing A Quality Assurance Program

Quality is achieved through the elimination of defects. There are two ways of eliminating defects. One is to eliminate (discard) the defective product prior to packing. The second way is to eliminate what is causing the defect. Both of these methods of eliminating defects are effective, but the most economical method is to eliminate or reduce the factors causing the defects.

This might include:

- Making the decision to harvest at the correct stage of maturity.
- Reducing handling to reduce handling damage
- Improving handling to reduce handling damage

It is a good idea to place a monetary value on damage caused. For example, if regular and documented inspections show that abrasion of fruit by rough containers causes damage to 5% of the peaches with a value of $80.00, it may not be cost-effective to line the containers with a plastic liner or “bubble pack.” If the losses are worth $5,000, changes in handling equipment or packing lines may be cost effective.

There are however, instances in which it may be necessary to break even or accept a reduced income, if not correcting a quality problem might mean loss of markets.

There are three components to a quality assurance program:

1) Determination of required quality,
2) Development of inspection procedures and
3) Reporting and use of results of the inspection.

1) Determination of the defects and level of defects to be included in the inspection, and the development of company standards or specifications.

Standards must be developed for products based on the country in which they will be marketed, and the customers to whom they will be sold.
The marketing division of a company should know what defects, and what level of defects are acceptable to the buyer. This will vary depending on the buyer. A buyer may request zero defects when 10% are normally allowed by the authorities in the importing country. In order to sell to that buyer, an exporter has to export fruit with 0% defects, as requested.

2) Development of written procedures for implementing inspections.

Inspection procedures must define who carries out the inspections, and how and where inspections are to be made.

i. Inspection

a. Quality controllers normally carry out inspections, but it is highly recommended that, from time to time, the packing plant foreman, marketing personnel, or management members be present to note the defects on the inspection form.

This helps develop a rapport and understanding between the quality controllers and management. Where quality controllers frequently find poor quality packed fruit, management including the packhouse manager, should:

- devise systems to ensure they have extra fruit to replace any defective fruits found in cartons during the inspection.
- most importantly – devise systems to stop the problem/defect fruit being packed, and devise systems to stop the problem/defect occurring. Re-packaging ('double-handling') is timely, expensive, and damaging to all the fruit in a consignment.

b. If the company has only one Quality control inspector, someone should be trained to take his/her place when he/she is absent.

c. Inspections should be carried out continually during the packaging phase — not just at the end of the day when there is little time to re-pack, or to eliminate commonly recurring problems. Ideally extra effort should be made at the beginning of the day — to identify and stop problems repeatedly occurring the working day, and toward the end of the day if packers are becoming tired and less attentive.

d. The first step in making a quality inspection is to determine the sample size for inspection.

Over-sampling is unproductive. 100% sampling has been found to be less reliable than random sampling of small lots. Sampling is usually determined statistically, based on the number of units to be packed (eg by inspecting 4-5% of cartons packed). Samples must be chosen “randomly,” that is, without any bias.

Occasionally, when certain packers are not packing as well as they should, units to be inspected are chosen specifically to determine how those packers are performing. As a general rule, all cartons or containers should have a packer identification number on the cartons - a system of identification allows corrective action to be directed at the source of a problem.

This specific type of inspection should be carried out in addition to the daily inspection sample that makes up the daily report.

The quality controller should not be restricted to only carrying out inspections. He should be free and able to move about during the day, watching all phases of the operation. He should also assist the various supervisors in their work, especially when a problem in a certain area has been encountered. For example, the emptying of peaches from picking bins to field bins may be too
rough and be causing damage. It may be necessary for the quality controller to help the field supervisor correct the problem.

The quality controller should visit various packing areas during the day. A formal inspection should be made at each station, but as the quality controllers gains experience, he/she should also make “visual” inspections of all the post harvest activities.

However, produce inspections, conducted formally and documented, are the only results which should be considered legitimate for decision-making.

ii. Quality Manual

Once the inspection procedures have been determined, a Quality Manual should be produced that includes copies of the product specifications, with a description of defects and how to rate each defect, the sample size to be taken, how to carry-out the inspection, where to collect the sample, how to do each required task and how to record and calculate the results.

An inspection form is required to record inspection data, make calculations of the data and note any observations. The form should have space to record:

- Date and location
- Packers name or code
- Type of product or pack
- Quality level being inspected
- Destination of the product
- Carrier of the product
- Any other descriptive information necessary
- Defects to be recorded, totaled and calculated as percentages
- Measurements such as pulp temperature
- Weights or counts to be entered
- “Observations” which are not specifically defects
- Signatures of the quality controllers and the plant foreman or his designate

Examples of inspection forms are shown in Section 5.6 of this Guide

Simple inspection of the packed product is usually carried out on an inspection table\(^{11}\), with weighing scale, located at the end of the packing line or near the packing tables, just after the cartons have been packed and before they are stacked on a pallet. This provides instant feedback on quality and allows for any adjustments or corrections to be made. At times it may be necessary to inspect product that has been held in storage just prior to the product being shipped, to be certain that the quality has not diminished during storage.

Where more complex inspection is being carried out, the quality controllers should have access to a Quality Control Room. The room, which must have a good water source for washing hands, and a separate water source for washing equipment, may be equipped with work tables, writing instruments/computer, calculator, and possibly a knife, calipers, thermometer, refractometer, penetrometer or other instruments, plus files/folders for keeping records.

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\(^{11}\) In some companies, Quality Inspectors are supplied with mobile tables/trolleys, which they can easily wheel from inspection area, to inspection area, taking with them all required weighing scales, paperwork etc.
iii. Monitoring Products Rejected for Packing

One of the principle objectives of a quality assurance program is to reduce losses. Losses can only be reduced if the reason for their being lost is understood. A simple way of accomplishing this monitoring is to inspect the rejects as they are discarded and to quantify the quality defects and where possible, the cause of the defect.

The quality controller should check the fruit which is rejected for packing, and assess its most obvious or most severe defects. The defects should be noted in an appropriate space on a “Waste Inspection Report.” Care should be taken not to rate as a defect any damage that may have occurred after the fruit was rejected.

If 40 tons of peaches were packed during the week and bruising was found to be 2%, it may not seem like a serious loss, but it represents 800 kg of fruit. This is significant; even more so if the loss continues for several weeks.

Rejects are losses. Even when the rejects may go to another outlet such as local market or processing, money is lost due to lower returns. Combining the results of the packed quality inspections and the inspection of rejects gives a better overall summary of the problems of defects. If 2% bruising is found in the packed fruit, the percentage of fruit rejected for bruising will very likely be higher.

(Note: Sometimes a piece of fruit without a defect may be accidentally rejected or rejected because the packer thought it was defective. If this occurs frequently, corrective action should taken.)

The results of the inspection will quickly develop a body of knowledge about the reasons for rejection and quantify the defects causing the rejections. As was previously discussed, this information can be used to make decisions on what losses can be economically eliminated or reduced.

Some defective fruit never leaves the field, the Quality Control inspector or even better – management - should visit to the field with the production personnel to gather information on “field losses”, and should determine what steps are necessary/economically effective to eliminate these losses.

It is not uncommon that varietal problems, cultivation practices, disease, pests or other factors will cause losses in the field. It may be difficult to quantify these losses, but an attempt should be made to do so with a reasonable amount of error. Losses should be recorded in figures:

e.g. “5 to 10% Damage by (ABC) insect”

Management needs numbers with which they can work.

3) Reporting

Once an inspection has been made and the information compiled and calculated, it must be reported to Senior Management, and/or the person(s) responsible for correcting the problem.

The quality controllers should not be responsible to the production or packing operations managers. It is very important that they be responsible to a management official not directly involved in production. In many companies or cooperatives the quality controller is directly responsible to the President or General Manager. In a large company there may be a vice-president of Quality Assurance to whom quality controllers reports. The reporting of quality will, at times, be a criticism.
of the production/packing operations and the quality controllers must be free of influence from those managers.

Copies of daily reports should be given to the packing operations management and the sales/marketing department. Certain defects may occur in transit, but most will not change. If the sales/marketing personnel have reliable quality data on their shipments, they can deal more easily with complaints from buyers who exaggerate quality problems.

The person to whom the quality controllers is responsible may also receive a copy of the daily quality reports, but will more likely receive a “weekly summary.”

The daily reports or summary should be used by management to make decisions about required changes or actions to reduce defects and losses. The quality controller and the packing operations management should immediately correct any malfunctions or other harmful procedures/activities causing quality problems. The quality controllers may also help train packers, when necessary.

The quality controller should be aware of everything that happens to the produce as it moves through the system to dispatch. He or she should always be looking for ways to improve the system or the ability of people to work in the system. For example, it may go unnoticed that the fruit remains too long in the sun and gets sunburned, or that field bins need to be lined to reduce abrasion of the fruit. The quality controllers can see the cumulative effects of all handling on the quality of the produce.

At times it may be necessary to send an quality controllers to the market to settle a dispute with a buyer. Eventually, with a well-managed company, the market will be less inclined to exaggerate quality problems. If a quality assurance program is properly managed, the sale/marketing personnel will always know what quality their product has in the market.

If quality is significantly different at the market from what it was in the company’s packing/storage operation, a problem may exist with transportation or with an operation poorly carried out, but unnoticeable at the time of inspection. An example of this may be the existence of small fungal infections over-looked during packaging, which developed during transport due to poor vehicle temperature control. Many companies exporting stone fruit retain market or shelf-life samples of fruit from each batch packed – eg one to five cartons from every batch. The samples are stored in controlled conditions (usually a Quality Assurance room or laboratory), and monitored for quality problems for several days, with observations recorded.

Quality assurance requires a commitment on the part of everyone in the management of a company. Quality assurance is good management at a price. It is a price a company must pay to stay competitive in the marketplace.

5.5 Quality Inspection Procedures

This Section details step-by-step instructions on how to make an inspection of peaches.

1. In the packing area, a sample - eg ten cartons of packed fruits - should be moved from the packing line, using a pallet mover or manual crate mover. They should not be carried by hand as this will result in more impacts and damage to the fruit than using crate movers.

2. The cartons are taken to a table where they can be opened and each peach can be inspected for defects. The table must be large enough to accommodate at least two cartons.
and a scale for weighing the cartons. The scale should be a platform scale with measurements in increments of 50 grams.

3. If the peaches to be inspected are packed by weight, it is necessary to record the total weight of fruit in each carton (excluding packaging). If the fruit is packed by count, weighing is not necessary. The fruit is handled gently and good quality fruit is repacked after inspection, excepting those fruit subjected to destructive analysis – eg fruit pressure (penetrometer) or soluble sugars (refractometer).

**Quality Characteristics to be assessed**

Three sample QA forms are included in this section, and producers may chose to use one of them, or a combination of all three. Suggested completion details for form A, are as follows:

1. **Size** should be the first thing checked when the carton is open – are all the fruit of uniform size and the correct size grade, as declared on the pack.

2. **Pack** refers to how loosely or tightly the fruit in the carton is packed. Form A should be used to record whether the fruit are packed Loose, Tight, or with Incorrect Materials, or whether they are Correctly Packed.

   A loose pack will allow the fruit to "roll" in the carton during transport causing serious damage. “Tight” means the pack was overfull and the fruit would be damaged by compression when the carton is closed. “Incorrect materials” means that any pads or trays used were not the correct ones for the pack or fruit size.

3. **Pulp temperature** is critical information if the product is going into storage or into a refrigerated shipping container or lorry. Record five fruit temperatures on the record form, and then calculate the average temperature. The fruit will be damaged by the temperature probe, and must be replaced with undamaged fruit from the grading line. Some buyers demand to know fruit brix (sugar levels); fruit tested for pulp temperature can be used for sugar analyses (ensure that fruit temperature is at 25 degrees centigrade before testing sugar levels).

4. **Pack Count** There are two types of packs; those packed by weight and those packed by count. For packs sold by the number of fruits in a container (‘count’), the quality controller should count the number of fruit in a pack, and record it (adjust Form A in Section 5.6 for this purpose).

5. **Pack Weight** If the pack label claims that, for example, the packed weight of fruit is 6kg, then the company must ensure that the weight of fruit never falls below 6kg. As fruit loses water and weight during the marketing chain, an additional 600g weight of fruit must be added to compensate for losses that will occur during transport and marketing.

   This additional weight is known as the tare weight. By adding a tare weight, the packer ensures that the actual weight of fruit in the box is never less than the declared weight on the box. Of course, packers must remember to include a 10% cost adjustment for product tare weight, when calculating sales prices.

   The pack weight will then be, for example:

<table>
<thead>
<tr>
<th>Fruit declared weight</th>
<th>6.0kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tare weight</td>
<td>0.6kg</td>
</tr>
<tr>
<td>Weight of packaging</td>
<td>1.0kg</td>
</tr>
<tr>
<td><strong>Total required pack weight</strong></td>
<td><strong>7.6kg</strong></td>
</tr>
</tbody>
</table>
6. **Packaging**  The Quality Controller should confirm that the packaging is correct, clean and undamaged.

7. **Pack Labelling**  Incorrect labeling is one of the major reasons why exported products are rejected at the country of import. It is vital that packs are correctly labeled, in accordance with the requirements of the destination country, and that quality controllers include inspection of labels in their assessments.

**Product Defects Inspection**

For each carton, the percentage of fruit affected with a defect must be recorded. If fruit has two defects, both should be recorded, to enable management to understand what problems are occurring during production and handling.

These are fifteen defects most commonly found on peaches. The following are brief descriptions of each defect:

1. **Color** – Depends on variety; frequently buyers specify their requirements (by variety), eg at least 1/3 of the peach must show red color; the base color must be light green or yellow, etc.

2. **Shape** – A peach is defective if the shape is not “well formed” for the variety.

3. **Abrasion** – Freshly abraded areas on fruit caused by friction during transport from field to packing operation, or too market. Abrasion does not affect the flesh of the fruit.

4. **Scab** – Small circular, olive-green or black spots that may occur individually or in clusters. Cracks and corky areas under skin may result.

5. **Bacterial Spot** – Darker brown than scab, not circular in form. Tissue becomes dry and cracked

6. **Gum Spot** – Sunken areas with a deposit of gum (resin) under the sunken area.

7. **Worm or Insect Damage** – Worms present or worm holes on fruit or damage by insects. This is a defect which is unacceptable in any class of fruit.

8. **Skin Breaks or Cuts** – Any break or cut in the cuticle.

9. **Hail Injury** – Irregular, more or less sunken areas which normally have dried fragments of skin and/or flesh around the sunken area.

10. **Leaf or Branch Rubs** – Rough, dark-colored areas caused by leaves or limbs rubbing against immature fruit.

11. **Growth Cracks** – Healed cracks on the fruit.

12. **Sunburn** – This defect causes skin and flesh discoloration.

13. **Bruising** – Bruises are areas discolored and flattened on one or more sides as a result of impact (eg dropping) or by compression - by pressure from packing too tightly.

14. **Decay** – The most common rots are Brown Rot and Rhizopus Rot. The rot does not need to be identified. Any rot should be noted on the form. This is a defect which is unacceptable in any class of fruit.

15. **Too soft** – Over-mature fruit that is very soft, or partly soft to the touch, or whose firmness pressures measured with a penetrometer are lower than those specified by the buyer.
When the quality controller has finished entering his assessment scores and carried out calculations, he and the person observing the inspection should sign the inspection form.

NOTE; If the fruit is going to be stored before dispatch to a client, another inspection should take place prior to dispatch; the carton should be marked to note that it has been previously inspected.

Reporting

A copy of inspection reports should go to the packhouse manager, one to company management and one to the quality controller's files.

Successful businesses are run on sound, reliable knowledge. Properly conducted and reported inspections contribute to this knowledge.
5.6 Suggested Record Forms
Form A: QA Record for Peaches and Nectarines

MOLDOVAN PEACH COMPANY Quality Assurance Form QA7/06P

<table>
<thead>
<tr>
<th>Date</th>
<th>Producer</th>
<th>Site of Production</th>
<th>Batch Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Brand</th>
<th>Destination</th>
<th>Transporter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CARTON NO:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pack, loose (L), tight (T) or correct (C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit Size Correct or Not Correct (NC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit Pulp Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brix (sugar levels)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging Clean and Correct Yes/No</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Labels Correct Yes/No</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**DEFECTS INSPECTION % affected**

| Colour |   |   |   |   |   |   |   |   |   |    |       |
| Shape  |   |   |   |   |   |   |   |   |   |    |       |
| Abrasion |   |   |   |   |   |   |   |   |   |    |       |
| Scab    |   |   |   |   |   |   |   |   |   |    |       |
| Bacterial Spot |   |   |   |   |   |   |   |   |   |    |       |
| Gum Spot |   |   |   |   |   |   |   |   |   |    |       |
| Worm or Insect Damage |   |   |   |   |   |   |   |   |   |    |       |
| Skin Breaks or Cuts |   |   |   |   |   |   |   |   |   |    |       |
| Hail Injury |   |   |   |   |   |   |   |   |   |    |       |
| Leaf or Branch Rubs |   |   |   |   |   |   |   |   |   |    |       |
| Growth Cracks |   |   |   |   |   |   |   |   |   |    |       |
| Sunburn |   |   |   |   |   |   |   |   |   |    |       |
| Bruising |   |   |   |   |   |   |   |   |   |    |       |
| Decay |   |   |   |   |   |   |   |   |   |    |       |
| Too Soft/Pressure recorded |   |   |   |   |   |   |   |   |   |    |       |

**TOTAL DEFECTS**

<table>
<thead>
<tr>
<th>Signature of Inspector</th>
<th>Signature of Observer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

Additional Comments:
**Form B: FINISHED PRODUCT DESPATCH QC FORM (All products)**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Data ambalării:</td>
<td>17.12.2005</td>
<td>Produsul și Soiul:</td>
<td>Piersici</td>
</tr>
<tr>
<td>Data livrării:</td>
<td>18.12.2005</td>
<td>Marimera lotului:</td>
<td>100</td>
</tr>
<tr>
<td>Nr. lotului:</td>
<td>2200</td>
<td>Nr. de cutii inspectate:</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cutia Nr.:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Massa cutiei:</th>
<th>12</th>
<th>12.1</th>
<th>12</th>
<th>12.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nr. de defete</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>% Conform</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>80%</td>
<td>100</td>
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<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>Temperatura pulpei:</th>
<th>9 9 9 9 9</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nr. de defete eval:</td>
<td>25 25 25 25 25</td>
<td>505</td>
</tr>
</tbody>
</table>

**Aspectul General al Ambalajului / Produsului:**

- Sunt respectate cerintele privind etichetarea.
- Eticheta este aplicata corect, imprimata clar si cieata.
- Ambalajul este conform (intact, curat).
- Culore caracteristica tipului / soiului. Culore uniforma in cutii.
- Luciul normal si aspect proaspat al fructelor.
- Epidema (coaja) fructelor este neteda.
- Pedunculul intact. Locul ruperii este curat, coaja adiacentă este intactă.
- Lipsa corpurilor straine, frunze, biețioare, etc.
- Fructe fragede si mustoase.
- Fructele nu au mirosuri si/sau gusturi straine neplacute.
- Dimensiuni uniforme. Fructe cu diametrul de ______ mm.

**Numarul de Defecte Majore**

- Cu semne de insecte vîi.
- Cu semne de putrefactie a epidermei sau pulpea provocata de ciupereci sau bacterii.
- Decolorare sau desfigurare, provocate de virusi.
- Tăieturi, despicături, găuri sau crăpături, mecanice sau provocate de dăunători.
- Apariția petelor brune pe epidermă.
- Cicatrice pe epidermă.
- Descompunere și pătarea brună a pulpei interne.
- Arsuri de soare sau arsuri de râcire/pre-râcire.

<table>
<thead>
<tr>
<th>Nr. de defecte</th>
<th>0</th>
<th>0</th>
<th>1</th>
<th>0</th>
<th>1</th>
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<tr>
<td>% Conform</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Numarul de Defecte Minore**

- Vănătări superficiale minore, mai intunecate decât culoarea epidermei.
- Leziuni vătâmate ale epidermei care afectează > 1 cm pătrat.
- Pata brună de la baza pedunculului > 6 cm pătrați.
- Culoare brună dispersata ce afectează > 2 cm pătrați.

<table>
<thead>
<tr>
<th>Nr. de defecte</th>
<th>4</th>
<th>3</th>
<th>5</th>
<th>2</th>
<th>4</th>
<th>18</th>
</tr>
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<tbody>
<tr>
<td>% Conform</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Numarul defectelor majore in cutie**: 3 3 5 2 3 16
**Numarul defectelor minore in cutie**: 6 5 6 2 5 24
**Nr. de cutii evaluate**: 100 102 99 101 103 505
**% Defecte Majore**: 3% 3% 5% 2% 3% 3%
**% Defecte Minore**: 6% 5% 6% 2% 5% 5%
**% Total Defecte**: 9% 8% 11% 4% 8% 8%

**Observații**: *
- Cutia 3 cu eticheta deformată.

---

**In cutia 2 umeda.**

---

**In cutia 1 5 fructe de soi si culoare necaracteristica (rosii).**

---

**Inspector Calitate** [Numele, Semnătura, Data]
### ABC GROWERS Ltd

<table>
<thead>
<tr>
<th>Field</th>
<th>Yes</th>
<th>No</th>
<th>% of defect</th>
</tr>
</thead>
</table>

**Date harvested:** …………………
**Product:** …………………
**Date packed:** …………………
**Variety:**
**Date despatched:** …………………
**Customer:**

**No. of boxes examined:** 
**Weights of boxes checked:**
**Field or Grower nos.:**

**Labelling:**
- Correct
- Incorrect

**Clearly printed:**
- Yes
- No

**Packaging in good condition:**
- Yes
- No

**Reason if no:**

### PRODUCT APPEARANCE

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>% of defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correctly colour graded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh looking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean, free of soil and extra moisture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size: Length and diameter correct?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size grading: uniform and correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free of Pests and disease/rots</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free from cuts and bruises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free of marks and blemishes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems present and in good condition?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free of foreign matter, leaves, sticks etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other observations**

**Signed:** ……………………………
**Date:** ……………………………
APPENDIX 1: Using a Refractometer

To use a refractometer:
° Cut a slice of a fruit between the fruit stem and flower scar.
° Lift the clear plastic cover of the refractometer, and squeeze juice on to the lens – without dropping pulp onto the lens.
° Carefully lower the plastic cover onto the juice – ensuring that a layer of pulp-free juice is trapped on the lens, without trapping any air bubbles.
° Look through the black eye piece – towards a gentle light source.
° A scale becomes visible, (which can be focused by twisting the black eye piece). The percentage sugars can be read from the scale.
° Testing the refractometer with drops of plain water should give a reading of zero.
° Between tests/after use, rinse the lens and lens cover with water, and dry with a scratch free cloth or paper.
APPENDIX 2: OUTLINE REFRIGERATION CAPACITY CALCULATIONS

COOLING CALCULATIONS
(from Doug York)

The following information is not the technical calculation a refrigeration engineer would make, but it has proven to be, and is intended as, a reliable general guide.

a. Horsepower Related to Refrigeration Capacity

The two most common refrigeration systems refrigerants for cooling and storage of fresh fruits and vegetables are Freon (R-22) and ammonia (R-717).

For general purposes, and based on normal operating conditions in the USA, available refrigeration capacity in tons of refrigeration (T.R.) is determined by noting the horsepower of the electric motor and using a multiplier factor as follows:

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-22 (Freon)</td>
<td>.70</td>
</tr>
<tr>
<td>R-717 (Ammonia)</td>
<td>.90</td>
</tr>
</tbody>
</table>

Worked Example of Refrigeration Capacity in tons of refrigeration (T.R.)

<table>
<thead>
<tr>
<th>Refrigerator’s Electric Motor Horsepower</th>
<th>Refrigerant</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>R-22</td>
</tr>
<tr>
<td>T.R. = 30 x .70 = 21 T.R.</td>
<td></td>
</tr>
</tbody>
</table>

b. Cooling Capacity Requirements

To calculate the cooling capacity needed to cool a given amount of product in a given amount of time you need to know the following:

1. Total weight of product to be cooled.
2. Incoming pulp temperature and desired cooled temperature.
3. Number of hours available for cooling.

Sample Calculation

1. 1800 cartons of peaches @ 10 lb\(^{12}\) per carton.
   (1800 X 10 = 18,000 lb.)

2. Incoming pulp temperature = 90° F
   Desired pulp temperature = 32° F
   Temperature to be removed = 58° F

3. Hours available for cooling, for example = 6 hr.

\(^{12}\) 1kg = 2.2lb
18,000 (lb of product) X 58° (temperature to be removed) = 1,044,000 BTUH (British Thermal Units per Hour).

To change BTUH into tons of refrigeration (T.R.), divide the BTUH by 12,000 (Number of BTUH per ton of refrigeration).

\[ 1,044,000 \div 12,000 = 87 \text{ T.R.} \]

The 87 T.R. is the tons of refrigeration required if all 18,000 lb. were to be cooled in one hour. Since that is not reasonable, a judgment factor of a reasonable cooling time is used. A reasonable cooling time could be 6 hours.

If 6 hours are available for cooling the product then the actual T.R. needed for the cooling load would be:

\[ 87 \text{ T.R.} \div 6 \text{ (hours available)} = 14.5 \text{ T.R.} \]

There are other heat factors that have to be added to the actual cooling load, (sometimes known as the parasitic heat load), these include heat generated by:

- Fans and pump motor loads
- Room air changes
- Lights, forklifts, and people
- Roof and wall conductance (transfer)

Generally a figure of 10% to 15% is added to the product load refrigeration requirement, to obtain an overall figure for refrigeration requirement.

Example:

\[ 14.5 \text{ T.R. (Product cooling load)} \times 1.15\% = 16.68 \text{ T.R.} \] (use 17 T.R.)

There are many other factors to be considered when calculating the refrigeration requirements for a pre-cooling or storage facility. These calculations are meant to provide a preliminary, quick calculation of required tonnage of refrigeration, and the refrigeration capacity from a refrigerator’s electric motor.

The cost of refrigeration equipment is high, but nonetheless it is important that an organization has sufficient refrigeration capacity to be able to quickly and thoroughly cool all fruit produced at times of maximum production/harvest.

NB: The refrigeration capacity needed to maintain fruit at its holding temperature in storage (after pre-cooling) is 0.08 to 0.11 tons per 1000 ft³ of storage volume.
ANEXĂ 3
STANDARD DE MARKETING PENTRU PIERSICI ȘI NECTARINE

I. DEFINIȚIA PRODUSULUI

Acest standard se referă la piersici și nectarine\textsuperscript{13} crescute din soiurile \textit{Prunus persica} Sieb. Și \textit{Zucc. L.}, pentru realizare în stare proaspătă, cu excepția piersicilor și nectarinelor pentru prelucrare industrială.

II. STIPLĂRI PRIVIND CALITATEA

Standardul prezent definește cerințele de calitate față de piersici și nectarine, după pregătire și ambalare.

A. Cerințe minime față de calitate:

Pe lîngă cerințele individuale din fiecare categorie și excepțiile permise, piersicile și nectarinele trebuie să fie:

- intacte,
- nedeteriorate; producția afectată de stricăciuni sau deteriorată astfel încît nu poate fi consumată, este exclusă;
- curate, practic lipsite de orice materie străină vizibilă,
- practic fără dăunători,
- practic nedeteriorate de către dăunători;
- fără umiditate exterioră anormală;
- fără miros și/sau gust străin.

Pe lîngă aceste cerințe, piersicile și nectarinele trebuie să fi fost culese atent.

Evoluarea și condiția caiselor trebuie să le permită:

- să reziste la transportare și manipulare, și
- să ajungă într-o condiție satisfăcătoare la destinație.

B. Cerințe minime față de maturitate:

Piersicile și nectarinele trebuie să fie suficient de coapte și maturate. Nivelul de evoluzione și maturitate a piersicilor și nectarinelor trebuie să le permită să-și continue procesul de coacere și să atingă nivelul cuvenit de coacere. Pentru a satisface această cerință, indexul miezului măsurat cu refractometrul în punctul de mijloc al pulpei fructului la secțiunea ecuatorială trebuie să fie mai mare sau egală cu 8 grade Brix, iar gradul de fermitate trebuie să fie mai mic de 6.5 kg măsurat cu un plonjor de un diametru de 8 mm (0.5 cm\textsuperscript{2}) în două puncte ale secțiunii ecuatoriale ale fructului.

C. Clasificare:

Piersicile și nectarinele sunt clasificate în trei categorii, după cum urmează:

i. Categoria „Extra”

Piersicile și nectarinele din această categorie trebuie să fie de o calitate superioară. Forma, evoluarea și culoarea trebuie să corespundă caracteristicilor soiului, funcție de regiunea în care au crescut. Nu trebuie să fie deteriorate, cu excepția unor defecte

\textsuperscript{13} Acest text se referă la toate soiurile crescute din \textit{Prunus persica} Sieb. Și \textit{Zucc.}, fie că sunt piersice sau nectarine sau altele similare cu sîmbure sau fără, cu coaja netedă sau aspră.
foarte superficiale care nu afectează aspectul general al fructului, calitatea, calitatea de păstrare și prezentarea în ambalaj.

ii. Categoría I:
Piersicile și nectarinele din această categorie trebuie să fie de o calitate bună. Ele trebuie să corespundă caracteristicilor soiului, funcție de regiunea în care au crescut. Sunt permise defecte minore ale formei, evoluării sau culorii.

Miezel trebuie să fie nedeteriorat.

Sunt excluse piersicile și nectarinele crăpate, la care tulpina este unită cu fructul.

Sunt permise piersicile și nectarinele crăpate ale cojii, dacă acestea nu afectează aspectul general al produsului, calitatea, calitatea de păstrare și prezentarea în ambalaj, și care să nu depășească:
- 1 cm la defectele de formă alungită,
- 0.5 cm² ca suprafață totală pentru alte tipuri de defecte.

iii. Categoría II:
Această categorie include piersicile și nectarinele care nu pot fi calificate pentru categoriile superioare, însă satisfac cerințele minime menționate mai sus.

Miezel nu trebuie să aibă defecte serioase. Fructele crăpate la locul unirii cu tulpina sunt permise numai în cadrul excepțiilor tolerate.

Defectele de suprafață sunt permise cu condiția că fructul își păstrează caracteristicile esențiale referitoare la calitate, calitatea de păstrare și prezentarea în ambalaj, precum și cu condiția ca acestea să nu depășească:
- 2 cm în lungime pentru defectele de formă longitudinală,
- 1.5 cm² din suprafață totală pentru alte tipuri de defecte

III. STIPULĂRI PRIVIND DIMENȘIUNEA
Mărimea este determinată de:
- circumferință, sau
- diametrul maxim al secțiunii ecuatoriale.

Piersicile și nectarinele trebuie clasificate conform următoarei grile de dimensiuni:

<table>
<thead>
<tr>
<th>Diametrul</th>
<th>Dimensiunea (codul)</th>
<th>Circumferință</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 mm și mai mare</td>
<td>AAAA</td>
<td>28 cm și mai mare</td>
</tr>
<tr>
<td>80 mm – 90 mm</td>
<td>AAA</td>
<td>25 cm – 28 cm</td>
</tr>
<tr>
<td>73 mm – 80 mm</td>
<td>AA</td>
<td>23 cm – 25 cm</td>
</tr>
<tr>
<td>67 mm – 73 mm</td>
<td>A</td>
<td>21 cm – 23 cm</td>
</tr>
<tr>
<td>61 mm – 67 mm</td>
<td>B</td>
<td>19 cm – 21 cm</td>
</tr>
<tr>
<td>56 mm – 61 mm</td>
<td>C</td>
<td>17,5 cm – 19 cm</td>
</tr>
<tr>
<td>51 mm – 56 mm</td>
<td>D</td>
<td>16 cm – 17,5 cm</td>
</tr>
</tbody>
</table>

Dimensiunea minimă admisibilă la fructele din categoria „Extra” este de 17,5 cm (circumferință) sau 56 mm (diametru).
Dimensiunea D (51 mm – 56 mm în diametru sau 16 cm – 17,5 cm în circumferință) nu este permisă în perioada 1 iulie – 31 octombrie.

Calibrarea este obligatorie pentru toate categoriile de fructe.

IV. STIPULĂRI PRIVIND EXCEPȚIILE TOLERATE
Sunt tolerate excepțiile privind calitatea și dimensiunea fructelor dintr-un ambalaj, care nu satisfac cerințele stipulate pentru fiecare categorie.

A. Excepții tolerate privind calitatea:

i. Categoriă „Extra”:
5% din numărul sau greutatea fructelor care nu satisfac cerințele față de categoria respectivă, dar care le întrunesc pe cele din categoria I, sau, ca excepție, care respectă limitele tolerate în categoria I.

ii. Categoriă I:
10% din numărul sau greutatea fructelor care nu satisfac cerințele față de categoria respectivă, dar care le întrunesc pe cele din categoria II, sau, ca excepție, care respectă limitele tolerate în categoria II.

iii. Categoriă II:
10% din numărul sau greutatea fructelor care nu satisfac nici cerințele față de categoria respectivă, nici cerințele minime, cu excepția fructelor afectate de putregai sau alte defecte care nu permit consumul acestora.

B. Excepții tolerated privind dimensiunea:
Pentru toate categoriile:
10% din numărul sau greutatea fructelor care deviază cu maxim 1 cm față de dimensiunile indicate pe ambalaj, în cazul măsurării după circumferință, sau cu maxim 3 mm în cazul măsurării după diametru. În cazul fructelor de dimensiunea cea mai mică, devierea față de limita minimă nu trebuie să depășească 6 mm (la circumferință) sau 2 mm (la diametru).

V. STIPULĂRI PRIVIND ASPECTUL
A. Uniformitatea:
Conținutul fiecărei ambalaje trebuie să fie uniform și să conțină numai piersici și nectarine de aceeași origine, soi, calitate, grad de coacere și dimensiune, iar pentru categoria „Extra” să fie de aceeași culoare.

Partea vizibilă a fiecărei ambalaje trebuie să reprezinte întregul conținut al acestuia.

Avind în vedere stipulările din prezentul capitol, produsele prevăzute de acest Regulament pot fi amestecate, în pungi de maxim trei kilograme, cu alte tipuri de fructe și legume proaspete, respectându-se condițiile prevăzute de Regulamentul Comisiei (CE) Nr. 48/200314.

B. Ambalajul:
Piersicile și nectarinele trebuie ambalate astfel încât să poată fi protejate adecvat.
Materialele utilizate în interiorul ambalajului trebuie să fie noi, curate și de o calitate care să nu permită dăunarea externă sau internă a produsului. Utilizarea materialelor, în special a hârtiei sau ștampilelor cu indicații comerciale, sunt permise numai dacă cleiul sau cerneala utilizată la tipărirea etichetelor nu sunt toxice.

Etichetele fixate pe fiecare fruct în parte trebuie să poată fi dezlipite astfel încât să nu lase urme de clei sau să deterioreze coaja fructelor.

Nu se permite prezența materiei străine în interiorul ambalajului.

C. Prezentarea:
Piersicile și nectarinele pot fi prezentate în modul următor:

- în cutii mici,
- într-un strat, în cazul fructelor de categoria „Extra”, fructele fiind separate între ele,

Pentru categoriile I și II:
- într-unul sau două straturi, sau
- în maxim patru straturi dacă fructele sunt aranjate în celule rigide, astfel încît fructele dintr-un strat să nu fie așezate deasupra fructelor din stratul inferior.

VI. STIPULĂRI PRIVIND MARCAJUL

Fiecare ambalaj trebuie să poarte următoarele însemnări, în litere grupate pe aceeași parte, scrise clar și cu cerneală rezistentă, fiind vizibile din exterior:

A. Identificare:
Denumirea și adresa întreprinderii de ambalare și/sau de livrare.

Această mențiune poate fi înlocuită în următoarele condiții:

- pentru toate tipurile de ambalaje, în afară de cele preliminare, mențiunea poate fi înlocuită cu codul acceptat și eliberat oficial pentru întreprinderea de ambalare și/sau transportare, indicat alături de cuvintele „Înțeprindere de ambalare și/sau transportare” (sau abrevierile echivalente);

- pentru ambalajele preliminare, mențiunea poate fi înlocuită cu denumirea și adresa întreprinderii de desfacere/comercializare înregistrată pe teritoriul Comunității, indicate alături de cuvintele „Ambalat pentru” sau o altă mențiune echivalentă. În acest caz, eticheta trebuie să includă și un cod al întreprinderii de ambalare și/sau transportare, Înțeprinderea de desfacere/comercializare va trebui să ofere toate datele considerate necesare de către autoritățile de științe în ceea ce privește însemnătatea codului respectiv.

B. Natura produsului:
- „Piersici” sau „nectarine” atunci când conținutul nu este vizibil din exterior,
- Culoarea miezului,
- Denumirea soiului (opțional).

C. Originea produsului:
Ţara de origine şi, opţional, regiunea unde au crescut caisele, sau denumirea zonei locale, regionale sau naţionale.

D. Date comerciale:
- categorie,
- dimensiunea, indicînd diametrul minim şi maxim, sau indicînd circumferinţa minimă şi maximă, sau arătînd codul conform stipulărilor capitolului III „Stipulări privind dimensiunea”,
- numărul de unităţi (opţional),
- conţinutul minim de zahăr, măsurat cu refractometrul şi exprimat în grade Brix (opţional),
- fermitatea maximă, măsurată cu penetrometrul şi exprimată în kg/0.5 cm² (opţional).

E. Marcaj al controlului oficial (opţional):

Ambalajele nu trebuie să poarte menţiunile specifice în primul sub-alinieat dacă conţin alte ambalaje vizibile clar din exterior care poartă deja aceste însemnări. Aceste ambalaje nu trebuie să mai poarte aceste înmelnări deoarece pot induce în eroare. Dacă aceste ambalaje sunt aşezate în palete, atunci înmelnările vor fi prezentate pe cel puţin două laturi ale paletei într-un loc evident.