RIPENING GUIDELINES FOR KIWIFRUIT RECEIVERS

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Featuring “ready to eat” (ripe) kiwifruit in your stores has proven to increase shelf turns at retail – a key component in produce department profits. A number of California kiwifruit growers and shippers are using our preconditioning protocols to supply you with ripe fruit early in the season. All California shippers can precondition upon request.

This information is designed to assist you in providing ripe kiwifruit to your clientele everyday. This brochure includes a simple guide to handling preconditioned kiwifruit and information on how to ripen kiwifruit yourself at the warehouse or store levels.

The easy-to-follow format outlines the following items:

- Determining stage of ripening
- Handling preconditioned kiwifruit
- Temperature ripening
- Ethylene ripening

Determining Stage of Ripening

Fruit firmness is the best measurement of ripeness. Fruit firmness is defined as the force necessary to break the flesh tissues and it is related to different ripening stages. For example, fruit firmness of a mature fruit varies from 16 - 12 pounds. During ripening, softening occurs, thus fruit firmness decreases reaching values of 2-4 pounds. When fruit reaches 2-4 pounds it is considered ripe or “ready to eat.” This is the level that kiwifruit will achieve its best eating characteristics. Minimum shipping firmness is suggested as 5 pounds, but it varied according to packing. Fruit with firmness below this level becomes more susceptible to physical damage during transportation and handling.

To determine the ripening stage, kiwifruit which arrives at your warehouse should be tested for flesh firmness using a standard fruit penetrometer with an 8.0 millimeter tip (5/16”). Fruit firmness should be measured on warm fruit (55-77°F).

As a general rule, non-preconditioned kiwifruit received in your warehouse which has been in storage less than four weeks or has a flesh firmness level of 8-10 pounds or greater should be treated further by using ethylene treatment to enhance ripening at the warehouse or store levels. Fruit which have been in storage equal or more than four weeks or has a flesh firmness of less than 8 pounds can be ripened to optimum levels by temperature management.
**Ethylene Ripening** Kiwifruit can be treated in existing banana or tomato ripening rooms using 10-100 ppm of ethylene per 6 hours. To avoid or reduce fruit shriveling, kiwifruit should be placed in ripening rooms in tray pack or volume fill packages with polyliners. Temperature setting postripening treatment will be set according to their predicted fruit consumption schedule using the relationship between post-treatment temperature and rate of softening (Table 1).

**Handling Pre-Conditioned Kiwifruit at the Warehouse/Store**

Pre-conditioned kiwifruit firmness must be tested upon arrival to the warehouse or retail store and handled according to its rate of softening (Table 1) and your rotation time.

Fifteen kiwifruit may be taken from the upper corner box in the pallet. A mature kiwifruit is usually harvested and shipped with a flesh firmness of 16-12 pounds-force (hard). Pre-conditioned kiwifruit should arrive at destination warehouses with firmness near 6-12 lbs-force but never lower than 4-5 lbs-force. Fruit arrival temperature should be lower or equal to 50°F.

Kiwifruit should always be kept at low temperatures (below 45°F), except if they are going to be consumed within 3 days. Keep kiwifruit enclosed with liners as long as you can.

Cooled kiwifruit enclosed with liners should be moved to the retail market before they reach a firmness of lower than or equal to 4-5 lbs-force to avoid vibration and impact bruising damage during transportation and handling (shipping point).

After delivery to the retail store, when kiwis reach the room temperature of 20-25°C (68-77°F), preconditioned kiwifruit will lose nearly 3 lbs-force per day. If kept at 7.5 to 0°C (45 to 32°F), kiwifruit will soften at a rate of ~ 2.0 lbs-force per day (Table 1). As kiwifruit reach 2-3 pounds and start to deteriorate during display (warm rack), kiwifruit can be placed in a cool room overnight or transferred to a cold rack if it is available to prolong their postharvest life. Frequent rotation and placing the softest kiwifruit at the front of the display are advised.

Consumers should be informed that preconditioned kiwifruit or ready-to-eat (2-3 lbs-force) kiwifruit must be refrigerated if they are not eaten immediately.

**Temperature Ripening**

If the flesh firmness is more than 5 pounds, but less than 10 pounds, its ripeness can be triggered and controlled at your warehouse by temperature management. The fruit temperature should be adjusted according to the anticipated consumption schedule based on the rate of softening (Table 1).
Table 1.

Rate of Kiwifruit Softening after Ethylene Treatment at 20°C (68°F).

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Rate of Softening</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>°F</td>
</tr>
<tr>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
</tr>
<tr>
<td>7.5</td>
<td>45</td>
</tr>
<tr>
<td>20</td>
<td>68</td>
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</table>
Update on Optimum Procedures for Ripening Kiwifruit

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Most consumers prefer to purchase kiwifruit that are near ripe ("ready to eat"). To ensure good tasting, "ready to eat" fruit, kiwifruit should be ripened at any step during postharvest handling before consumer consumption. This is essential for early season, freshly harvested kiwifruit. To assure good flavor of kiwifruit when ripe and maximum storage potential, we suggest picking them when they reach at least a minimum of 6.2% SSC measured in the field or ~15-16% dry weight (DW). Using either parameter, the titratable acidity at consumption should be below 0.9%. We use firmness measurements at maximum maturity to protect kiwifruit from mechanical damage and fast softening during storage. Kiwifruit below 14 pounds are physiologically active (ethylene producers) and may become a source of ethylene contamination to other sound kiwifruit. Flesh firmness is the best indicator of kiwifruit ripening and best predictor of shelf life. Fruit that measures 2-3 pounds-force flesh firmness is ripe and "ready-to-eat."

Ripening at the Shipping Point Ethylene Pre-conditioning Treatment

Ethylene applied at 100 ppm by using the "shot system" for 12 hours within a 0 to 20°C (32 to 68°F) temperature range will induce ripening as indicated by uniform kiwifruit softening and starch conversion into sugars. Ethylene exposure can be shortened to 6 hours by using a catalytic generator (C2H4) or flow-through application system. Ethylene pre-conditioning treatment (100 ppm for 12 hours) is only effective on freshly harvested kiwifruit or those that have been in cold storage for less than 5 weeks. Fruits kept in cold storage for longer than 5 weeks will ripen upon transfer to ripening temperatures of 59-70°C (15-21°F) by their own ethylene so exogenous ethylene application is not needed.

The temperature setting during treatment and shipment should be adjusted according to the anticipated consumption schedule. To prevent softening due to delayed shipments, apply ethylene to cold kiwifruit. Cold kiwifruit treated at near 0°C (32°F) and maintained at that temperature may be held up to 5 weeks. These kiwifruit will reach a firmness of about 3 pounds in 2 to 3 days after being transferred to 20°C (68°F).

Application of Ethylene Pre-conditioning Treatment

Place kiwifruit in a ripening room with good temperature and relative humidity control. The type of kiwifruit container such as tray pack, clam shell, volume fill packages, or tri-wall containers with polyliners do not interfere with the preconditioning treatment including ethylene application. The ripening room should be located far away from any packing facilities to avoid
ethylene contamination of long-term storage kiwifruit. High relative humidity (90-95%) is especially recommended when ripening is carried out at temperatures higher than 7.5°C (45°F).

The temperature setting during treatment and shipment should be adjusted according to the anticipated consumption schedule (Table 1).

When ethylene treatment is applied to warm kiwifruit, they will soften very fast even when stored at cold temperatures after the treatment. If shipping is delayed after treatment, fruit will reach a firmness of about 3 pounds-force within six days when held at 0°C (32°F).

Table 1. Rate of kiwifruit softening after ethylene treatment at 20°C (68°F).

<table>
<thead>
<tr>
<th>Temperature °C</th>
<th>Days to reach a firmness of 3 lbs-force</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.5 to 7.0</td>
</tr>
<tr>
<td>7.5</td>
<td>6.0 to 7.0</td>
</tr>
<tr>
<td>20</td>
<td>3.0 to 4.5</td>
</tr>
</tbody>
</table>

Cold kiwifruit (~33°F) treated at or near 0°C (33°F) and maintained at that temperature may be held up to 5 weeks. These cold treated kiwifruit will reach a firmness of about 3 pounds-force in 2 to 3 days after being transferred to 20°C (68°F). In both cases, the temperature setting during storage and transportation should be close to 0°C (32°F).

**Ripening at the Retail End**

As a general rule, non-preconditioned ripened kiwifruit received in your warehouse that have been in storage less than 4-5 weeks or have a flesh firmness level of 8-10 pounds or greater should be ripened by using ethylene at warm temperature.

Pre-conditioned kiwifruit firmness must be tested upon arrival to the warehouse or retail store and handled according to its rate of softening and your rotation time. Fruit that has been in storage equal to or longer than 4-5 weeks or have a flesh firmness of less than 8 pounds can be ripened close to “ready to eat” by temperature management only.

In all cases, temperature conditions for kiwifruit during storage treatment should be adjusted according to your anticipated marketing/selling schedule. The flesh softening rate of kiwifruit is about 2.0 pounds per day when exposed to 20°C (68°F). Softening can be slowed down when fruit is stored at lower temperatures.

In general, kiwifruit should always be kept at low temperatures below 7.5°C (45°F) and enclosed with liners, except if they are going to be consumed within 3 days.
References


