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Harvest and Handling Considerations - Florida Greenhouse Vegetable Production Handbook, Vol 1[1]

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Besides the initial capital investment in the greenhouse structure for crop production, thought must be given to the requirements for proper harvesting, packing, and shipping. Each of these operations are interrelated, and must work smoothly together to maintain quality for maximum postharvest life. Specific postharvest operations depend on the particular greenhouse facility and on the number and types of crops grown. The principal considerations for these components are outlined below

Maintaining Quality

The primary goal of harvest and postharvest handling is to maintain vegetable quality as close as possible to harvest condition through subsequent handling operations. Maintaining high quality is the thread that links each of the components in the harvest/handling system, and carelessness at any stage can quickly change the grade. Typical quality parameters include color, firmness, size, shape, flavor, aroma and freedom from injury and disease.

Vegetable quality is most often reduced by two factors: mechanical injury and poor temperature management. Mechanical injuries include cuts, abrasions, and punctures incurred during harvest and handling operations, and bruises caused by drops or overfilled containers. These injuries provide entry points for decay organisms and reduce storage life. Proper temperature management involves the rapid removal of field heat shortly after harvest to the optimal storage temperature (known as rapid cooling, or precooling). Once cooled, the product should be kept at that temperature, usually with high relative humidity, during subsequent handling and storage.

Harvest Operations

Crops must be harvested at the optimal maturity for the intended use. Proper harvesting techniques are also essential for minimizing mechanical injury. Frequent sanitizing of hands/gloves and clippers can assist in reducing damage and disease. A reusable picking container must be selected that has smooth inner surfaces, is not too deep and is made of an

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easily cleanable material, such as plastic. After harvest, the product should be protected from the sun to prevent temperature increase. Provision should be made for gently transporting the harvested product to the packing/storage area. Prior to reuse, the containers should be cleansed and sanitized to minimize the spread of decay pathogens.

Packing Operations

Knowledge of USDA grade standards and consistent application of these standards during packing are critical for a quality pack (see references below) The packing area should be located near the greenhouse. It should be large enough to contain any packing line equipment necessary for sorting, sizing, washing/waxing of certain crops; permit storage of excess inventory, such as containers, labels, etc., and adjoin any cooling/storage facility. As harvest volume increases, motorized conveyors become more efficient than stationary tables for grading and packing by permitting better definition of employee tasks. Proper disposal of wastewater should also be addressed according to local regulations.

The shipping container is a critical component in maintaining quality during handling and shipping. It should be compatible with the intended crop and provide adequate ventilation for rapid cooling, while at the same time be durable enough to protect the product during shipping (Fig. 1). The cooling method affects container material. If the container will be exposed to direct contact with water or ice, it must be a waxed, corrugated carton, wooden wirebound crate or plastic returnable container (RPC). If air is used to cool the product, a waterproof container is not necessary, although corrugated containers must be strong enough to withstand absorption of water vapor during handling and storage in high humidity. RPCs are becoming more common as buyers shift to these types of standardized containers (Fig. 2).

The shipping container should also be clearly labeled as to crop, grade, count, weight, and shipper. By stacking the containers on standard pallets (40 inches (100 cm) x 48 inches (120 cm), considerable handling time and costs can be saved. Containers should have base dimensions that permit complete

Figure 1. Corrugated shipping containers are commonly used for packing greenhouse vegetables.

Figure 2. Use of returnable plastic containers is increasing. Note that the trays in the RPC's are stood on end to reduce bruising during handling.

coverage of the pallet surface, with five to 10 containers per layer.

Use of pallets, however, increases initial costs for a fork lift or pallet jack, pallets, and strapping equipment. Rental options for both the RPCs and pallets make these handling systems competitive with purchase of cartons, crates and pallets. Also, sufficient space must be reserved for to accommodating fork lifts in the packing area .

Cooling and Storage

Postharvest life and quality can be significantly extended by removing field heat within a couple of hours of harvest. Although there are several methods used for rapid cooling, two of them are best-suited for smaller operations. **Forced-air cooling** is one of the easiest methods to implement using an existing cold

room. In this method, high-capacity fans are installed in certain configurations in the cold room so that the cold air is quickly pulled over the product (Fig. 3). A well-designed system can cool packed vegetables in less than 2 hours, after which the crop can be stored in the same cold room until shipping. Forced-air cooling is suited for a wide range of vegetables including those that cannot tolerate direct contact with water, such as peppers. It is also fairly inexpensive compared to the other methods. A humidifier should be installed in the cold room to maintain 85 to 90% relative humidity, to minimize water loss during cooling and subsequent storage.

Figure 3. A small-scale, forced-air cooler can be sit up in a cold room. In the set-up, the fan pulls the cold room air through the vented, plastic containers to revoce field heat.

A second method that can be adapted to small operations is **hydrocooling**. Crops tolerant to contact with water can be exposed to refrigerated water either individually (the most efficient way) or packed in field or shipping containers (Fig. 4). During hydrocooling the water quickly lowers the pulp temperature of the crop - from 10 minutes for medium-sized cucumbers, to 45 minutes for cantaloupes, to an hour or more for palletized crops. Since the initial investment in refrigeration and handling equipment is more costly than that for forced-air cooling, hydrocooling is better suited for higher volume operations. Ice also cools hydrocooling waterl and, for smaller growers, is a lower-cost alternative to mechanical refrigeration systems.

Figure 4. Fastest hydrocooling occures when water contacts individual fruits. Here the melon are exiting a shower type hydrocooler.

Prewashing is recommended prior to hydrocooling to minimize accumulation of debris in the hydrocooling water. Since hydrocooling water is reused, debris must be constantly removed and the water must be continually sanitized to avoid accumulation of pathogens that could lead to storage decay. Shipping containers must be waterproof.

Both of these cooling methods provide flexibility in cooling to a wide range of final temperatures. Optimal temperatures vary, depending upon the crop. Certain vegetables, are chilling-sensitive meaning that they develop pitting and/or off-color in the peel and off-flavors during storage at temperatures above freezing. Examples of chilling-sensitive crops are pepper, cucumber, squash, and eggplant, which should be stored no colder than 50°F (10°C). Tomatoes should be held no colder than 53°F (12°C). Leafy crops maintain best quality when stored near 32°F (0°C). The cooling operation must be carefully managed to assure efficient and reliable removal of field heat, while not excessively cooling which could cause injury. Once cooled, the product must be kept cold during storage, handling, and shipping to gain the benefits of slowed ripening and senescent processes and slowed growth of decay pathogens. Reliable temperature and relative humidity probes must be used to verify storage conditions.

Cooling systems and cold storage rooms should be constructed by contractors with experience in the perishable produce industry. Cold rooms should be constructed to maintain high relative humidity (up to

95%, depending on the crop) to avoid excessive water loss during storage. The cold room should be designed so that the refrigerated truck can park directly against the cold room for loading.

Electric fork lifts or pallet jacks are preferred to propane-powered fork lifts. Internal combustion engines produce exhaust that is a safety hazard to workers in confined spaces such as cold rooms. Ethylene gas is also generated and can damage fresh produce at concentrations as low as 1 part per million. Ethylene injury symptoms include premature yellowing of green crops, abscission of leaves and fruits, and accelerated ripening, softening, and decay.

Sanitation and Food Safety

Postharvest decay and the risk of contaminating the product with human pathogens can be markedly reduced by implementation of an on-site sanitation program. A successful program should include use of a foot bath at all entry points to the greenhouse. The bath must contain sufficient sanitizing solution at all times. Plant material (prunings, etc.) and culls from picking containers and packing areas serve as reservoirs for pathogens and insects, and should never be stockpiled near the facility. When a decay outbreak occurs, additional precautions are warranted, such as more frequent sanitizing of tools and restriction of employee movement to reduce the possibility of infecting other crops. Reused water, such as in wash tanks, should contain an approved sanitizer, such as chlorine.

A regular cleaning and sanitation program includes use of an approved sanitizer or steam for picking containers (after each use), packing area (daily), and cold room floors and walls (bi-weekly) to reduce accumulation of decay organisms. Any disposal of wash water or culls should be done in a manner approved by local environmental regulatory agencies. Employees should be provided with adequate restroom facilities and required to thoroughly wash their hands after each use with clean water and soap.

The above considerations must be analyzed in light of each greenhouse operation. Following these guidelines will greatly help produce and ship products with consistently high quality and postharvest life.

More Information

Handling, cooling and sanitation techniques for maintaining postharvest quality. S.A. Sargent, M.A. Ritenour and J.K. Brecht. Vegetable Production Guide for Florida SP170 pp. 81-90. University of Florida; Citrus & Vegetable Magazine. 2000.

Relevant Web Sites:

North Florida Research & Education Center-Suwannee Valley. http://nfrec-sv.ifas.ufl.edu.

Postharvest Horticulture at the University of Florida. http://www.postharvest.ifas.ufl.edu

Protected Agriculture Project. Horticultural Sciences Department. http://www.hos.ufl.edu/ProtectedAg/

U.S. Dept. of Agriculture. Grade Standards for Fresh Fruits and Vegetables. http://www.ams.usda.gov/standards/index.htm

University of Florida Cooperative Extension Publications. http://edis.ifas.ufl.edu/

For the other chapters in the Greenhouse Vegetable Production Handbook, see the documents listed below:

Florida Greenhouse Vegetable Production Handbook, Vol 1

Introduction, HS 766

Financial Considerations, HS767

Pre-Construction Considerations, HS768

Crop Production, HS769

Considerations for Managing Greenhouse Pests, HS770

Harvest and Handling Considerations, HS771

Marketing Considerations, HS772

Florida Greenhouse Vegetable Production Handbook, Vol 2

Florida Greenhouse Vegetable Production Handbook, Vol 3