STORAGE MANAGEMENT

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Potato tubers are living, respiring, biologically active organisms that require optimal storage conditions to maintain the quality that is present at harvest. Successful storage requires that growers have an understanding of the factors that affect tuber health and quality.

Storage Structures

Several companies design and build modern potato storages, and any one of these businesses can provide the latest information on construction. To provide optimum storage conditions for potatoes, certain essential design and equipment characteristics must be present. These include:

- Sufficiently strong foundation and lateral wall support to hold the weight of the pile.
- Adequate insulation and moisture barrier.
- An air circulation system capable of providing a uniform supply of air to the entire storage.
- Equipment for supplying moisture to the circulation air.
- Some method for raising or lowering air temperature, or maintaining it within a desired range.
- Adequate sensors and controllers to allow maintenance of optimal conditions in the absence of an operator.

Preharvest Decisions

Before storing a potato crop, consider these factors:

- Potatoes affected during the growing season by temperature extremes, nutrient excesses or deficiencies, water stress, physical damage, or other unfavorable growing conditions may not respond to storage environments equally.
- Potatoes that are bruised or damaged during any part of the harvesting, hauling, piling, or storing operations may require additional considerations for proper storage management.
- Most modern storages can provide conditions that will allow the presence of some rot at the beginning of storage. As little as 1 to 3 percent rot can make potatoes difficult to store. In a modern storage facility, as a general rule, potatoes with up to 5 percent wet rot can be successfully stored if proper procedures are employed to eliminate excess moisture. The same is true for tubers damaged by frost.

- If potatoes are approaching an off-grade at harvest because of net necrosis, they should either not be stored or marketed within the first 2 months of storage.
- Potatoes with severe stress-related problems, such as sugar ends or jelly ends, or high overall sugar levels, should also be considered for immediate delivery.

Storage Cleaning and Maintenance

Disinfection or cleaning of the storage facility is a good practice in all storages and is essential for seed producers. In most potato producing states, the Department of

Agriculture maintains a current listing of available registered products that can be used for storage disinfection. Off-season care of the potato storage facility is important in maintaining the functionality of the facility and to enable long-term storage of high quality potatoes.

One to three months before harvest:

- Repair all insulation materials.
- Clean plenum and duct ports thoroughly.
- Replace worn humidity equipment and high pressure nozzles.
- Check for corrosion on all surfaces.
- Service the air system and check all fans for proper balance.
- Repair or replace worn components on air louvers.
- Calibrate all computerized sensors that are used for control functions.
- Service the relative humidity supply cell decks.

Filling the Storage

Potatoes entering the storage should be free from dirt and rocks and should be handled in a manner that minimizes damage. This can be accomplished by observing the following practices:

- Use well-maintained unloading, even-flow bins, and/or sorting equipment for delivery of potatoes from trucks to the storage.
- Keep all drops to 8 inches or less and pad all sharp or hard surfaces on handling equipment.
- Keep all equipment running smoothly and full to capacity with potatoes.
- Use roll prevention belts on pilers and steep elevators.
- Pile the potatoes using a tier system.
- Use only well-trained personnel to operate piling equipment.

Early Storage and Wound Healing

Freshly harvested potatoes can exhibit potential problems that are not apparent in the field. The first few days of storage are the time to recognize and address these problems Potatoes harvested at pulp temperatures above 65°F can be much more prone to rot and quality problems than cooler potatoes. Every effort should be made to rapidly cool freshly harvested potatoes to below 60°F within 2 or 3 days of harvest. Unless there is a significant amount of wet rot present in the potato pile, high humidity (>95%) should be maintained during the cooling process. Potatoes coming from the field into storage usually go through a period of wound healing before storage holding temperatures are attained. This wound-healing period may take from 2 to 3 weeks depending on the variety and the temperature at which the tubers are maintained.

Tubers may quickly repair bruises, cuts, scrapes, or surface damage if adequate temperature and high-humidity air supply are available. Standard storage operations include an initial holding period at 50° to 60°F until this healing process has concluded. Temperatures below 50°F may reduce the rate of wound healing, thereby extending the length of storage periods that would be required to provide adequate protection to the tubers. Temperatures above 60°F may increase disease development before the wound healing process can be completed.

Wound healing is an extremely important component in reducing disease spread and minimizing shrinkage loss during long-term storage. However, it is also important to avoid keeping the tubers warm for an extended period of time because most rot organisms spread much faster at warm temperatures.

Air Circulation

Basic principles of managing circulation air in a potato storage include the following:

- Ventilation fans should be operated to cool the pile; to maintain a 0.5° to 2°F temperature difference between the top and bottom of the pile for long-term storage of processing potatoes; or to provide fresh air.
- Use circulation air that is cooler than the tubers at the bottom of the pile.
- Operate humidifiers whenever circulating air unless there is a need to remove excess moisture from the pile.
- Keep circulation air at or near 95 percent relative humidity.
- Begin circulating air before the first potatoes come into the storage and do not end until the last of the tubers is removed.

Storage Temperatures

Optimal holding temperatures for potatoes in storage depend on the potato variety and the intended end use of the product. Processing potatoes are generally stored between 44° and 50°F to limit the concentration of reducing sugars in the tuber tissue. By comparison, potatoes intended for fresh market may be stored between 40° and 50°F, while those intended for seed are usually stored at 38° to 40°F. Although there is usually little consideration of table quality as it relates to storage temperature, the best quality is maintained at 44° to 47°F.

Storage temperatures are also used to minimize weight losses caused by respiration and shrinkage. Respiratory losses are usually minimal near 45°F. Tuber weight loss due to respiration alone can equal 1.5 percent of the total weight over an 8- to 10-month storage season.

An increase or decrease in potato storage temperatures can be used to minimize disease development. By reducing holding temperature, many storage disease problems can be minimized.

Reconditioning refers to the use of elevated pile temperatures to help reduce the accumulation of reducing sugars in tubers. Higher temperatures increase the tuber respiration rate, thereby decreasing detrimentally high reducing sugar concentrations so that the processed potatoes meet the industry requirements.

Temperature changes in storage should be gradual and not exceed recommendations for various product uses. The rate of downward ramping of storage temperature for potatoes intended for processing should follow guidelines established by the processing industry. In general, temperature reductions should not exceed 0.5°F per day when cooling to specified holding temperatures. This gradual temperature reduction helps eliminate changes in the sugar content of tubers that can affect processed product quality. Guidelines for proper holding temperatures in storage may vary with the variety. For processing potatoes it is critical that minimal sugar accumulation occurs.

Relative Humidity

Most of the tuber shrinkage that occurs during the first month of storage results from water lost before the completion of the wound healing process. Maintaining high relative humidity in potato storage prevents some of the early season tuber dehydration and helps control the total shrinkage loss during the season. Shrinkage loss in storage is directly proportional to the length of the storage season and inversely proportional to the relative humidity conditions maintained within that storage. The current recommendation is to maintain 95 percent RH or above for minimizing early storage tuber losses due to dehydration.

Free moisture is one of the most common problems traced to rot organism spread in storage. Condensation can become a problem when it occurs directly on the tubers or on any inside surface of the storage. Maintaining circulation air slightly cooler than the bottom of the pile will help prevent condensation directly onto the tubers. Likewise, condensation on building surfaces can be minimized by providing adequate insulation and making sure there is enough air movement to keep surfaces warm and to evaporate the moisture that collects before it drips onto the potatoes.

Sprout Inhibition

Successful long-term storage of potatoes requires using a sprout inhibitor in combination with proper storage management. CIPC, or chlorpropham, is the most effective post-harvest sprout inhibitor registered for use in potato storages in the United States. This product has been used successfully as a sprout inhibitor for more than 40 years. CIPC must be applied after the wound-healing period is over but before dormancy break or initiation of sprout growth.

Sprout Inhibition Failure

Occasionally, stored potatoes that have been treated with CIPC have internal or external sprouting problems. Inadequate sprout inhibition is often thought to be a result of application factors, such as product failure or incorrect application rate. However, numerous factors may cause sprouting problems in storage:

- Improperly designed air systems.
- Improper sizing, spacing, or placement of the air ducts.
- Hot spots in the pile caused by disease, excess dirt restricting air flow, and/or plugged air vents.
- Field-stressed potatoes.
- Potatoes stored under fluctuating temperatures and humidity.
- Late-season application (usually after dormancy break) of CIPC.

Internal Sprouting

Internal sprouting is a disorder in which a lateral sprout grows inward into the tuber or outward into an adjacent tuber. This tuber defect occurs mainly in long-term storage, and then only occasionally. The causes of this disorder are not well understood but appear to be related to a lack of CIPC on or around tightly packed tubers.

Varieties

Each variety may react differently to CIPC. The application of CIPC should be timed to ensure that the sprout inhibitor is applied early enough in the storage season. Knowledge of varietal differences in dormancy length is important for successful long-term storage.

Alternative Sprout Inhibitors

Several essential oils extracted from plant materials are effective potato sprout suppressants. Substituted naphthalenes have been successfully used to suppress sprout development. Also, researchers are evaluating several hydrogen peroxide-based materials for sprout suppression in storage. *Please refer to **Potato Production Systems** book for more detailed information* (Order Potato Production Systems).

Storage Disease Management

Many post-harvest disease problems are associated with field locations where water saturation or excessive soil moisture occurs. These areas need to be identified before harvest so that the resulting tubers can be stored only if the storage facility is capable of handling problem lots. Storage diseases are difficult to control when tuber infection approaches 1 to 3 percent unless the storage facility is equipped to supply high volumes of air. Soft rot, water rots, dry rot, and tuber blights are the most common disease problems in long term storages.

Bacterial Pathogens

Soft rot, caused by the bacteria *Erwinia carotovora,* is the most serious of all storage diseases. This organism will spread rapidly from tuber to tuber if the conditions are appropriate. In addition, they can infect other sites where fungal diseases, such as dry rot, are present. Storage management includes high airflow to those infected areas to prevent the spread. Researchers have found little evidence that growers ca n control bacterial soft rot by applying disinfectants or bactericides to the circulation air that moves through the potato pile.

Fungal Pathogens

Dry rot, caused by *Fusarium sambucinum,* can be a serious storage disease of potatoes. However, control of this pathogen is usually accomplished by proper handling and harvest conditions. *Fusarium sambucinum* can only infect tubers through wounds in the tuber skin, which occur mainly during harvest or handling.

Wet spots in the pile at the beginning of storage are usually associated with pythium leak *(Pythium ultimum*). Pythium leak is not related to wet soil conditions but to harvest wounds in connection with high tuber temperatures. This disease is often more severe under dry harvest conditions because hard clods cause more tuber damage.

Another water rot that may come into the storage from field locations with saturated soil conditions is *Phytophthora erythroseptica* or pink rot. It may spread in storage if a secondary bacterial infection occurs. Control measures include constant fan operation to dry out the infected tubers before they can become a problem.

Silver scurf, caused by the fungus *Helminthosporium solani,* is a troublesome condition that causes silvery blotches on the surface of the tuber. This disease can also spread in storage if conditions are right for spore germination. Although tubers are usually downgraded because of surface blemishes, the disease organism does not cause storage rot or decay of the infected tubers. Control conditions in storage include lower relative humidity and storage temperatures to limit surface growth of the fungus. However, reducing the humidity and decreasing the storage temperatures may limit marketing strategies.

Late blight (*Phytophthora infestans*) and early blight (*Alternaria solani*) are usually considered to be foliar diseases. However, both also have destructive tuber rot phases. Late blight-infected tubers will decay slowly in storage but can become infected with bacterial soft rot that will accentuate tuber decay and allow the soft rot to spread rapidly in storage. Late blight infection will not spread in storage but a potential exists for tuber infection if wet conditions occur in storage. Early blight lesions can limit the marketability of infected tubers, but this disease does not cause tissue breakdown in storage. Both early blight and late blight infected tubers are normally a result of field infection during harvest and handling. Control measures with frequent fungicide sprays during crop growth can minimize infection before harvest and, thus, limit the impact of tuber blights in storage.