# Commercial Application of CIPC Sprout Inhibitor to Storage Potatoes

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**Modern** potato storages (fig. 1) are designed to store 50,000 to more than 500,000 hundredweight (cwt) of potatoes in bulk piles. Successful long-term storage of potatoes requires using a sprout inhibitor in combination with proper storage management. Chlorpropham (CIPC) is the most effective post-harvest sprout inhibitor registered for use in potato storages in the United States. Its use as a potato sprout inhibitor was first reported by P. C. Marth in 1952 and later patented by the Pittsburgh Plate & Glass Co.

CIPC inhibits potato sprout development by interfering with spindle formation during cell division. However, cell division is extremely important during the wound healing, or curing, period after potatoes are placed into storage. Wound healing requires the production of two to five new cell layers by cell division. If CIPC is applied before the wound healing process is complete, excessive losses due to tuber dehydration and disease can occur.

## Commercial application methods

CIPC is applied as an aerosol or emulsifiable concentrate (EC). Commercial applicators licensed by the Idaho Department of Agriculture apply the CIPC aerosol formulation to bulk potatoes in storage. Fresh pack shed operators apply the EC formulation to potatoes as a direct spray during the fresh packing operation.

Applying CIPC commercially to potato storages requires years of experience using specialized equipment as well as familiarity with storage design and aerosols (fig. 2). Before a commercial applicator applies CIPC to a potato storage, the applicator checks the air systems and adjusts them to reduce the air velocity, checks and records tuber pulp temperatures, and prepares the building for the application.

**Figure 1.** *Facility for storing 250,000 cwt of potatoes. This storage has a center plenum for delivery of air into two separate storage bays.*

## CIPC and seed potatoes

**Do not** store seed potatoes in a structure where CIPC was recently used or in a structure close to a building where CIPC will be applied. Contamination of seed lots by CIPC can occur up to one year after treatment. Currently, there are no methods to rapidly decontaminate a storage structure after CIPC application. If fans, ducts, and plenums are thoroughly cleaned of all CIPC residue and warm air is circulated through the storage during the summer period, then seed can be safely stored in the storage the year *following* cleanup.

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Commercial applicators currently use two methods to apply the aerosol formulation of CIPC. The most common method utilizes an aerosol-generator (fig. 3), which is usually mounted on a vehicle for mobility. The application equipment is positioned close to a storage fan house. A stainless steel pipe connected to the aerosol-generator extends through ports in the outer wall of the storage fan house.

CIPC as a liquid concentrate is pumped into the aerosol-generator, which is heated by either propane or gasoline. As the CIPC exits the generator, it cools to 104°F or lower and forms microscopic crystals that make up the aerosol. The CIPC crystals are carried by the circulating air stream down the plenum, into the air ducts, and up through the potato pile. As the CIPC moves through the pile, the crystals are deposited on the surfaces of the tubers. The time to complete the application process ranges from 4 to 10 hours depending on the size of the building and the volume of potatoes.

After the aerosol fog has cleared, the applicator enters the building and removes any residue on fans, fan guards, plenum, and other surfaces in contact with the chemical. When the cleaning process is complete, the storage controls are reset to pretreatment conditions, allowing the fans to resume normal operation.

The second method uses a hot plate heated by propane or electricity instead of heated air to vaporize the CIPC. This procedure was first used in the developmental phase of CIPC storage treatment by Pittsburgh Plate & Glass Co. and is still used by some applicators.

**Figure 2.** *During treatment the CIPC aerosol is circulated throughout the potato pile by the circulation fans. The aerosol quickly fills the air spaces around the potatoes and inside the building as it is being deposited on the potato surfaces.*

The method used to form the aerosol is not as important as the consistency of aerosol application to the potato tuber surface. To improve the consistency of application, a reduced-fan-speed technique was developed to slow the air that carries the CIPC through the potato pile. This technique reduces the air velocity to 10 to 50 percent of normal flow. This change from the original full-fan-speed application methodology has drastically reduced the loss of CIPC due to impingement and settling of the compound on floors, walls, and equipment.

## Application rates

A standard application rate is 1 pound active ingredient (a.i.) per 600 cwt of unwashed potatoes, but the rate may vary depending on commercial formulation, potato variety, end-product use, storage temperature, and length of intended storage. For information concerning the required rates, consult the commercial applicator or the product label.

## Application timing

CIPC may be applied any time after the wound healing process is complete and before the tubers break dormancy in early spring. The healing process requires approximately 14 to 21 days, after the last potatoes are placed into storage, at 50° to 55°F.

In Idaho, Russet Burbank potatoes normally start to break dormancy (sprout) in January or early February, depending on the storage temperatures. If CIPC is applied before the sprouting process starts and before the potato pile has a chance to settle, the odds for prolonged sprout suppression are very high. However, if CIPC is applied after the pile has settled and sprouts are elongating, suppression may be inconsistent or the buds may be only slightly delayed from sprouting. At this point in the storage season, CIPC may have limited success in sprout suppression.

## Storage preparation

Storage preparation for the commercial application of CIPC to stored potatoes is minimal. Storage managers should contact the commercial applicator for specific recommendations before preparing a storage for CIPC application.

CIPC has an affinity for water so the humidity system, the plenum, and the air ducts need to be dry. The humidity system is usually turned off at least two or more days prior to the aerosol application, depending on the type of system in the storage. An evaporative-cooling-pad system may take longer to dry. Some commercial applicators remove the cen-

ter section of the cooling system from the air flow and cover the pads with plastic, thus making it unnecessary to dry the evaporative cooling cells. Drying the air washer-type system consists of draining or covering the water reservoir. Bypass doors in some storages are also used to direct the CIPC around humidity systems.

## Sprout inhibition failure

Occasionally, stored potatoes that have been treated with CIPC have internal or external sprouting problems. These problems usually occur in the mid to latter part of the storage season. 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 can cause the potato pile to have a temperature differential from top to bottom, with the top being three or more degrees warmer. This temperature differential causes increased respiration of the tubers, which may induce earlier sprouting.

• Improper sizing, spacing, or placement of the air ducts may result in nonuniform pile temperatures and uneven air circulation.

• Hot spots in the pile from disease, excess dirt restricting air flow, and/or plugged air vents can cause elevated pile temperatures that may result in premature sprouting. This condition may be localized in a small spot or, if undetected, may spread to larger parts of the pile.

• Field-stressed potatoes may respond differently to CIPC application in storage than potatoes grown under nonstressed conditions. For example, potatoes grown under deficient nitrogen conditions will sprout earlier than adequately fertilized potatoes. Other field stress conditions (disease, water balance, nutrition, temperature) also may reduce sprout inhibitor effectiveness.

• Potatoes stored under fluctuating temperatures and humidity may physiologically age faster than potatoes stored under a nonfluctuating temperature and humidity environment. CIPC may not inhibit sprouting of these aged tubers during long-term storage.

• Late-season application of CIPC produces mixed results, ranging from adequate sprout inhibition to complete failure.

## Internal sprouting

Internal sprouting is a malformation in which a lateral sprout grows inward into the tuber or outward into an adjacent tuber (fig. 4). 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 potatoes.

Storage environmental factors such as temperature and pile pressure on tubers seem to be important. Some research has indicated that an insufficient sprout inhibitor concentration due to pile settling, excess soil or debris in the pile, or a too-late application can accentuate the problem.

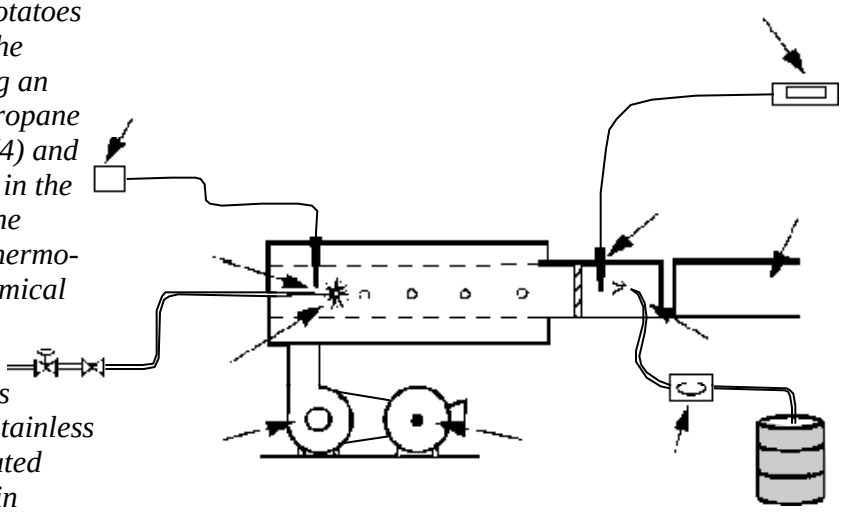

**Figure 3.** *Typical thermal fogging equipment used to convert liquid CIPC to an aerosol for application to potatoes in storage. The motor (1) drives the high-pressure blower (2), creating an airflow through the burner (3). Propane is introduced through the nozzle (4) and ignited electronically (5). The air in the combustion chamber is heated. The temperature is measured with a thermocouple (6) and displayed (7). Chemical is pumped (8) into the hot air stream through a chemical injection nozzle (9). The aerosol is carried into the storage through stainless steel tubing (10) and then distributed throughout the storage by the main plenum fans.*

## General recommendations

1. For long-term storage use structures insulated to withstand outside temperature extremes. The air system should supply 0.5 to 1 cfm/cwt of air, and the environmental control systems must minimize storage temperature and humidity fluctuations.
2. Ensure all potatoes in the storage have had adequate time to heal by waiting 14 to 21 days (depending on the storage temperature and the potato variety) after the last potatoes are placed into storage before treating with CIPC.
3. Follow the commercial applicator's pretreatment storage preparation requirements.
4. Do not apply CIPC after potatoes have broken dormancy and started to sprout.
5. Do not store potato seed in a storage where CIPC has been applied the previous year without first cleaning it thoroughly.
6. Do not store potato seed in a structure that is close to a storage that will be treated with CIPC.
7. Follow all label safety requirements after CIPC application or when entering a treated storage. Consult your licensed applicator for safety information.

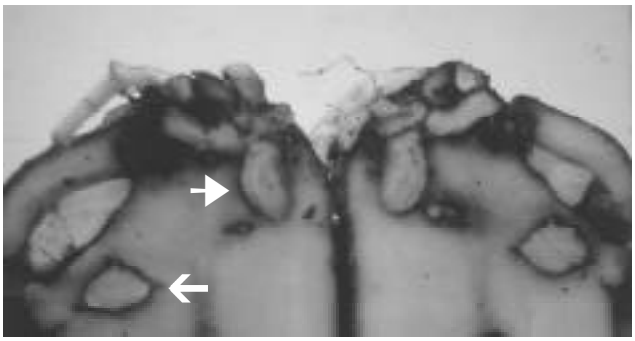

**Figure 4.** *Potatoes that have internal sprouts are not acceptable for marketing.*

## Varieties

Each variety may react differently to CIPC. Traditionally, early maturing varieties, which are harvested and delivered directly to the processor or fresh packer, were not stored. However, in the early 1990s, Shepody, an early maturing white skinned variety, was placed into storage, treated with CIPC shortly after curing, and successfully stored for several months. Chipping varieties that are usually stored at 50°F have been successfully stored into late April with the use of CIPC. Later-maturing varieties, such as Russet Burbank, can be stored for 12 months under optimal conditions with little loss of quality. More information concerning storage requirements for specific potato varieties is contained in PNW 454, *Characteristics of Potato Varieties in the Pacific Northwest.*

## Safety procedures

Caution is advised for anyone entering a potato storage after CIPC has been applied and before the fog has settled. All personnel should wear respirators and proper protective clothing until the aerosol has settled out of the air. Consult a licensed commercial applicator for more information. Always read and follow label directions.

## Further reading

*Characteristics of Potato Varieties in the Pacific Northwest*, PNW 454, $5

Order from Ag Publications, Idaho Street, University of Idaho, Moscow, ID 83844-2240, (208) 885-7982, cking@uidaho.edu


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