University of Idaho Extension

BUL 907

Best Practices for CIPC Residue Sampling of Potatoes and Storage Facilities

Mary Jo Frazier and Nora Olsen

Introduction

Best management practices for long-term storage of commercial potatoes may require the use of sprout inhibitors, most commonly CIPC (chlorpropham; isopropyl N-(3-chlorophenyl) carbamate). CIPC has been registered and used safely for potato sprout control for more than 60 years. It is widely utilized throughout the United States and globally.

The use of CIPC allows delivery of high-quality potatoes to consumers and potato processors throughout the year. Sprout inhibitor applications will not improve the quality of poor-quality potatoes, however, and do not replace proper management of ventilation, temperature, and humidity in storages.

Using a "best practices" approach to CIPC application and sampling CIPC residues in storages will contribute to the stewardship of this economical, effective product and help to ensure its continued use in short- and long-term storage. This publication provides a uniform, documented method for CIPC residue sampling in commercial potato storages and a sampling protocol for surface swabbing for CIPC residues in storages intended for seed potatoes.

CIPC mode of action and use in potato storages

CIPC inhibits sprout development by interfering with cell division. Since this mode of action will also interfere with wound healing, CIPC application must take place after the wound-healing period but prior to dormancy break. Sprout development may vary in response to growing-season conditions, storage temperature, and variety, and application timing of CIPC needs to be adjusted accordingly.

In the United States, licensed professional applicators apply CIPC to bulk potatoes in storage as a thermal aerosol. Early application of CIPC after wound healing allows for effective distribution of the chemical before pile settling occurs.

Thermal aerosols are produced by vaporizing chemical in a superheated, forced-air stream. The aerosol can then be circulated through the pile using the storage's ventilation system. Low-speed recirculation of CIPC through bulk piles results in the most uniform CIPC deposition (see Kleinkopf et al., 1997, for more information). All humidification equipment should be turned off prior to, and during, CIPC application. Pile fans, refrigeration equipment, and other air-handling equipment should be turned off during CIPC application as well.

Variety, storage temperature, planned length of storage, market use of the crop, and quality of the storage need to be considered when determining CIPC application

Contents

rate. Vigorously sprouting varieties such as Russet Norkotah and Ranger Russet may require higher rates than varieties with longer dormancy periods such as Russet Burbank. Warmer storage temperatures (48–60°F) may require higher CIPC application rates than lower storage temperatures (40–48°F). Refer to the current product label for rate-specific recommendations.

Monitoring CIPC concentrations in storages

Monitoring CIPC residue will give the storage manager valuable information regarding the chemically induced dormancy of the stored potatoes. The maximum allowable residue level in the U.S. is currently 30 ppm, but residue levels of stored potatoes are typically far less than 20 ppm. When CIPC residue falls below 1 to 2 ppm on a whole-tuber basis, sprouting may occur (see Corsini et al., 1979, for more information).

When residue levels are too low to prevent sprouting, potatoes may lose weight as multiple sprouts are initiated in the eyes, cellular metabolism increases, and carbohydrate conversions occur. Sprout development creates a greater surface area for water loss. Sprout control is also important to maintain the proper temperature of the pile, which could be affected when spouts impede airflow and respiration increases. Internal sprouting defect may also be more prevalent when CIPC residue levels are suboptimal.

Regular, periodic physical inspection of the crop is recommended. Repeated CIPC residue sampling over time can be used to indicate if retreatment may be necessary or when it may be necessary to market/deliver the crop. An initial residue sample may be collected a few days after CIPC application and a second sample after 1 to 2 months to estimate the rate of chemical loss over time. If the reported result is below 2 ppm (whole-tuber basis) and several more months of storage are desired, retreatment may be required to prevent sprouting. Duration from time of application to sampling can impact the residue level. It may be necessary to resample the storage to verify the low residue level. Residue sampling can also provide information about the uniformity of the sprout inhibitor application.

Standard protocol for CIPC residue sampling of tubers

Methods or protocols for obtaining CIPC residue samples tend to differ with each custom application company, processor, or individual. This publication provides a uniform, documented method for CIPC residue sampling in commercial potato storages. A standard protocol enables:

- Direct comparisons of CIPC residues between and within storages
- Development of estimates for when sprouting may occur
- Scheduling of processing or packing based upon residue levels and the potential for sprouting
- Documentation of adherence to maximum residue levels

CIPC residue levels are just an indicator of sprouting potential. Factors such as condition of tubers at harvest, overall potato quality, variety, storage temperature, quality of storage facility, and time in storage should also be considered when estimating potential sprout development.

It is important to note that analytical procedures to quantify CIPC residues vary between laboratories. CIPC residue comparisons can only be made between tuber samples that were analyzed by the same analytical laboratory.

Potato tuber CIPC residue sampling guidelines

1. Ensure your safety.

- Enter a potato storage only when it is safe to do so. Contact the storage manager for permission and to ensure there are no other ongoing treatments. If entering a storage alone let a contact person know where you are and when you should return.
- Do not enter a storage without respiratory protection provided by an organic-vapor or pesticide-removing respirator cartridge and personal protective equipment (PPE) such as long sleeves, pants, and shoes until 10 fresh-air exchanges have been completed after the CIPC application. This may occur after 2 hours of forced-air ventilation.

- When entering a storage facility immediately after a CIPC treatment, you must read, understand, and follow all label guidelines and PPE requirements for the CIPC product that was applied.
- If you must pass through the fan house to sample, for safety, it may be necessary to temporarily stop fan circulation while tuber residue samples are being collected.
- Wear headlamps, long pants and sleeves, and soft-soled shoes with traction (running shoes) in poorly lit, often-slippery environments.
- Do not smoke or eat while in or around potato storages.

2. **Wear clean gloves and use clean, heavy-duty recloseable plastic bags for sample collection.**
   - Perforation of the bag may be necessary to avoid condensation in the bag, which may influence residue analysis.
   - Avoid touching storage surfaces and random tubers with your gloves prior to sampling.
   - Replace your gloves before you take each replicate sample or when you sample another building.
3. **Collect tuber samples from approximately 1 foot below the surface of the pile.** Samples obtained from the surface can be more variable in residue levels than samples collected below the surface (figure 1).
4. **Use a zigzag or random sampling pattern when collecting tuber samples from multiple locations.**
   - Crossing the storage back and forth while walking the length of the pile and sampling tubers at intervals will reflect the variability within the storage. Residue variability can be much higher for samples selected from a single location (figure 2).
   - Sampled tubers should be visibly free of disease but otherwise selected randomly, with the goal of collecting a representative sample.
5. **Take a composite sample of 12 to 24 tubers for a more representative analysis than composite samples containing lower tuber numbers** (figure 3). Taking composite samples with even higher tuber numbers is not recommended to avoid difficulties in obtaining the sample and in extracting residue at the laboratory. With smaller-sized tubers it may be necessary to sample a higher number of tubers to reach a sample size of approximately 5 pounds or more.
6. **Sample each lot or bay in each building separately.** If there is variability in sprouting, a partially filled storage, or other known variabilities, such as storage design, additional replicates may be needed.

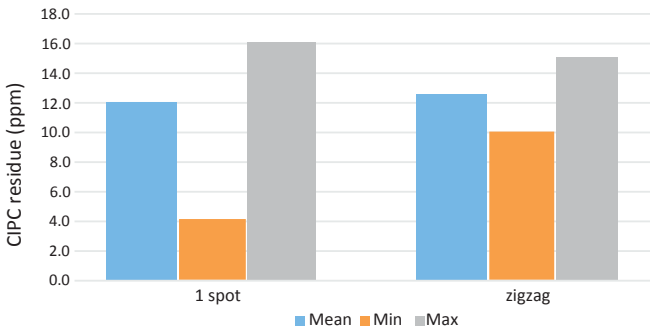

Figure 2. Mean, minimum, and maximum CIPC residue levels (ppm) in samples taken from a commercial storage in a single spot or in a zigzag pattern. Greater variability in residue levels is seen in samples taken from one location.

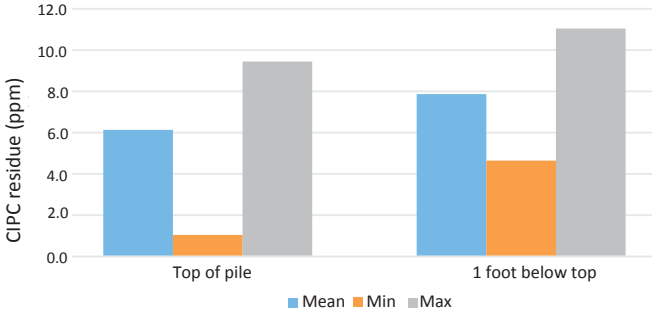

Figure 1. Mean, minimum, and maximum CIPC residue levels (ppm) in samples taken from the top of the pile or from the 1-foot depth in commercial storages (approx. 100,000 cwt). Greater variability in residue levels is seen in samples from the top of the pile.

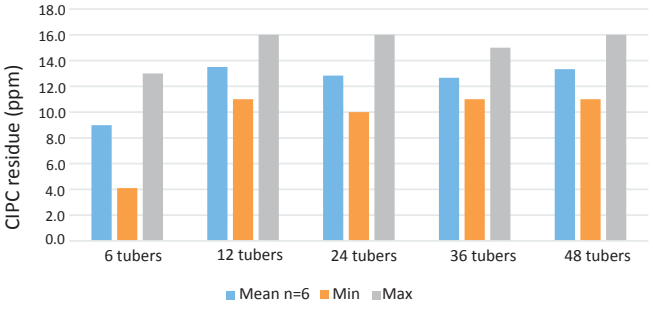

Figure 3. Mean, minimum and maximum CIPC residue levels (ppm) of composite samples of various tuber numbers from commercial storages. Less variability in residue levels were observed with 12 or more tubers per composite sample.

7. **Do not attempt to remove dirt from tubers in the sample. Do not wash them.**
8. **Handle tubers as little as possible.** Handle samples in a manner to prevent contamination.
9. **Keep samples cool and deliver them to the analytical lab as soon as possible.** Research has shown a change in residue concentration over time and with temperature prior to processing (table 1).
   - Refrigerate samples not processed on the day of collection.
   - Prevent contamination between samples.
10. **Ask the analytical laboratory to immediately process/pulverize the whole unwashed sample and freeze it until final analysis.** Ensure the laboratory's protocol does not require washing the tubers, as this may decrease CIPC residue levels. Light brushing is recommended if excessive soil is adhering to the tubers.

Table 1. CIPC residue levels (ppm) in samples analyzed immediately or after 2 to 4 weeks in refrigeration or at room temperature. Different letters indicate significant differences at $P \leq 0.05$.

	Russet Burbank Lot 1	Russet Burbank Lot 2	Russet Norkotah
Immediate analysis	3.0 a	1.4 a	2.2 a
Refrigeration 2 weeks	1.9 b	0.8 b	2.2 a
Refrigeration 4 weeks	2.1 ab	0.2 c	2.2 a
Room temperature 2 weeks	0.9 c	0.3 c	1.1 b

11. **Ask the analytical laboratory for their handling and sampling procedures.** Results should be reported in parts per million (ppm), which is equivalent to mg/kg.

Record keeping

Record keeping is important for the financial health of your farm as well as for documentation of Good Agricultural Practices (GAP) and of traceability requirements. The storage manager will want to keep a written record of the details of the sprout inhibitor application and of residue sampling. These records and product labels should be on file. Custom applicators will maintain copies of the same records.

CIPC records or logs

CIPC application records, or logs, should contain the following information:

- Storage ID
- Address
- Storage manager name
- Date of application(s)
- Applicator
- Product name, EPA registration number, and batch/lot number
- Application rate
- Volume treated or pounds of potatoes
- Pounds of product applied
- Application duration
- External weather conditions
- Storage temperature during application (range)
- Fan speed
- Crop variety
- Crop condition
- Crop identification

Records to accompany residue samples and results

Include this information with tuber residue samples taken to analytical laboratory and in your results record:

- Sample ID
- Storage ID
- Sampling date
- Number of tubers in sample
- Storage manager name
- Address to send results
- Crop variety
- Crop identification
- Date of delivery to analytical lab
- Residue result

CIPC residues and seed potatoes

Swabbing storage structure surfaces for CIPC residue may indicate the relative contamination level in a building and help ensure the safety of potato seed to be stored there. Seed inadvertently contaminated with CIPC may have delayed emergence, and yield losses can result. CIPC residue on seed as low as 0.6 ppm can result in more than a 30-day delay in emergence and 36% decrease in yield (see Frazier and Olsen, 2015, for more information).

Cleaning storages for seed potatoes

CIPC label restrictions must be closely followed regarding the cleaning and decontamination procedures necessary for storing seed in a building that has been previously treated with CIPC. Complete and thorough cleaning of all surfaces (i.e., walls, fans, plenums and ducts) is required. In addition, 6 months must have elapsed since the removal of treated potatoes. Removal and replacement of the top 2 inches of soil on the floor is also recommended. CIPC label restrictions should be closely followed regarding the cleaning and decontamination procedures necessary for storing seed in a building that has been previously treated with CIPC. Do not attempt to store seed in a building that has been treated with CIPC unless these restrictions are followed.

Sampling protocol for surface swabbing for CIPC residues

It is best to use this sampling protocol to indicate if a storage has been adequately cleaned.

Materials needed for sampling storage and handling equipment surfaces are available at most drug stores: clean disposable gloves, small, zip-type plastic storage bags with labels, markers, a ruler, isopropyl alcohol, and 2-inch sterile gauze pads.

1. **Use caution when entering a potato storage** as indicated in the sampling procedures outlined under "Potato Tuber CIPC Residue Sampling Guidelines."
2. **Select a location in the storage for swabbing.** Swab areas of concern such as the main plenum wall (near application port), storage walls, ducts, and fan blades. Different storage building materials can vary in CIPC adherence. If multiple materials are present, sample each material separately.
3. **Using a ruler or some other template, draw a 1-square-foot sampling box** on the surface of the area to be sampled.
4. **Don clean gloves.**
5. **Unwrap a sterile gauze pad and saturate the pad with isopropyl alcohol.**
6. **Carefully wipe across the outlined sampling area** with the saturated gauze pad, systematically swabbing the whole 1-square-foot area. Note: porous material, such concrete or wood, can snag the gauze pad, making it difficult to swab.
7. **Immediately seal the pad in a clean storage bag and label** for delivery to the laboratory. Add information on where and when the swab was collected to your records.
8. **Repeat from step 1 in different areas** if additional samples are desired.

Interpreting swabbing results

The residue will be reported in ppm (ug ai/g swab) and represents the amount of chemical on the surface of the swabbed area. Interpreting the results is more problematic. Cleaning and disinfecting storages using the procedures recommended on the label reduced residue on treated storage walls by 80 to 99% and resulted in residue levels below 20 ppm.

Conclusions

- Stewardship of CIPC use will help ensure adherence to label recommendations and prevent exceedance of the maximum residue levels.
- Use CIPC tuber residue levels for guidance only. Other factors will also impact sprout development.
- CIPC residue levels in storage facilities can provide an indication of proper cleaning and that enough time has elapsed to minimize the risk of CIPC exposure to seed.

References

Corsini, D., G. Stallknecht, and W. Sparks. 1979. Changes in chlorpropham residues in stored potatoes. American Potato Journal. 56:43–50. http://link.springer.com/article/10.1007/BF02851122

Kleinkopf, G. E., T. L. Brandt, M. J. Frazier, and G. Moller. 1997. American Potato Journal. 74:107–117. http://link.springer.com/article/10.1007/BF02851556

Frazier M. J., and N. Olsen. 2015. The effects of chlorpropham exposure on field-grown potatoes. American Journal of Potato Research. 92:32–37. http://link.springer.com/article/10.1007/s12230-014-9408-6

Authors— Mary Jo Frazier, Support Scientist, and Nora Olsen, Extension Potato Specialist, Kimberly Research and Extension Center, University of Idaho

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Barbara Petty, Director of University of Idaho Extension, University of Idaho, Moscow, Idaho 83844. The University of Idaho has a policy of nondiscrimination on the basis of race, color, religion, national origin, sex, sexual orientation, gender identity/expression, age, disability or status as a Vietnam-era veteran.

Published July 2016