University of Idaho College of Agricultural and Life Sciences

CIS 1120

Organic and Alternative Methods for Potato Sprout Control in Storage

Mary Jo Frazier, Nora Olsen, and Gale Kleinkopf

Effective sprout control is a major component of managing stored potato quality. If proper sprout control is not maintained, significant reduction to tuber quality will occur, and the ability to store for extended periods of time is diminished. Sprouting causes increased weight loss and may impede airflow through the potato pile. Reduced airflow often leads to increased pile temperatures and an increase in disease problems. Sprouting is also associated with the conversion of starch to sugars, which is undesirable in the processing industry due to darkening of fried products. In the table stock industry, visible sprouts on potatoes are unacceptable to consumers.

The length of dormancy differs by cultivar and storage temperature. Understanding the cultivar differences in dormancy length is important in choosing the appropriate storage temperature for the cultivar and knowing when to apply the sprout control product. Examples are given in Table 1. Russet Burbank will store longer than most red and white skinned cultivars and many russeted cultivars.

Alternative materials for sprout suppression are limited once the end of the dormancy period has been reached and potatoes are sprouting. One method to delay sprout development is with cold temperature storage (38-42°F). These cooler temperatures can lengthen the marketing window by retarding sprout development, but potatoes may begin to sprout once placed in a warmer environment such as at a grocery store or consumer's pantry.

Table 1. Temperatures & Dormancy The approximate number of days until dormancy break for six russet cultivars are shown at three storage temperatures. (Kleinkopf, G. and N. Olsen, 2003. Storage Management. *In* Potato Production Systems, *Eds*. J. Stark and S. Love. p. 375.)

	Approximate dormancy length in days		
Potato Cultivar	42°F	45°F	48°F
Russet Burbank	150	135	120
Ranger Russet	75	60	50
Gem Russet	135	115	90
Summit Russet	150	125	100
Umatilla Russet	140	120	80
Bannock Russet	135	110	80

Note: This publication reports results of a series of projects conducted at the University of Idaho Potato Storage Research Facility in Kimberly, Idaho to evaluate alternative potato sprout suppression product efficacy and best application methods. Special thanks to funding support from the Idaho Potato Commission.

Cold temperature storage will also result in an increase in reducing sugar content, primarily glucose. Higher concentrations of glucose cause products to fry dark resulting in unacceptable product color. Therefore, low temperature storage is not appropriate for potatoes destined for the processing market. Fluctuations in the pile temperature may promote sprouting. For that reason, storage temperatures should remain as consistent as possible.

After mid-winter, nearly all potatoes available in commercial markets have been treated with a chemical sprout inhibitor, such as chlorpropham (CIPC). CIPC is the most commonly used post-harvest sprout inhibitor in the United States. CIPC inhibits sprout development by interfering with cell division, and, generally, a single application maintains long-term sprout control. Alternatives to CIPC are needed for both organic and export markets—where CIPC is not permitted.

Essential oils as alternatives to CIPC

Research from the University of Idaho has evaluated several compounds that can be used for effective sprout suppression. All are classified as "Generally Recognized as Safe" (GRAS) by the U.S. Food and Drug Administration. This GRAS designation means the FDA has approved the substance for addition to food. The USDA National Organic Program has approved non-synthetic GRAS compounds for application to certified organic crops. Oils of some herbs and spices—essential oils—have been shown to reduce sprouting in potatoes and can be applied to certified organic crops. These compounds are volatile plant derivatives including spearmint oil, peppermint oil, and clove oil. Other compounds, such as hydrogen peroxide, may also

have sprout suppression properties. Hydrogen peroxide is also allowable by the federal organic standards.

These alternative compounds are not true "sprout inhibitors" that inhibit sprouting by interfering with cell division or some other biological process. Volatile oils and hydrogen peroxide are more correctly called sprout suppressants, as they physically damage developing sprouts with a high concentration of the product in the surrounding headspace in the potato storage. Because of high volatility, these compounds leave behind little or no residue. Since new sprouts continue to develop, repeat applications are required at two to three week intervals or on a continuous basis.

Application methods

Application methods will differ with these alternative products. CIPC is typically applied with a thermal applicator at high temperatures to create an aerosol or thermal fog that is circulated in the storage ventilation system. These types of applications may not be best suited for efficient distribution of more volatile compounds. Other means of applying the oils would be to create a cold aerosol, or utilize a wick volatilization method. A wicking, or forced evaporation, method entails saturating the volatile oil on absorbent material and placing the material near the air circulation fans for distribution in storage.

The following information contains results of projects conducted at the University of Idaho to evaluate alternative sprout suppression product efficacy and best application methods.

Mint oils

Peppermint and spearmint oils applied in storage can be used as effective sprout suppressants (Figure 1). A wick application of these oils gave better sprout control than thermal or cold aerosol applications. This "low-tech" wick method can be as simple as placing a small piece of blotter paper saturated with mint oil in the box of potatoes. For potatoes in bulk storage, mint oil can be volatilized into the air stream circulating through the potatoes by creating a

Figure 1. Mint Oils Sprout development from peppermint and spearmint oil treated tubers compared to untreated tubers.

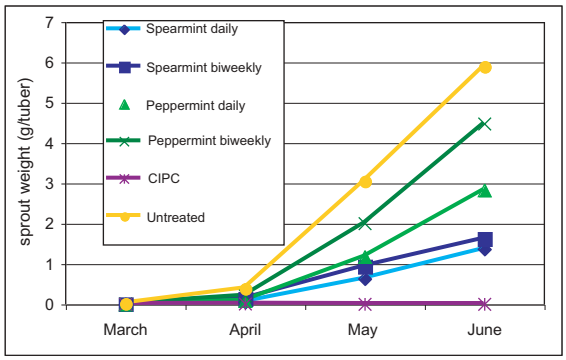

Figure 2. Mint Oils Sprout growth of Russet Burbank potatoes with spearmint and peppermint oil applied daily, or wick applications biweekly, are shown flanked by CIPC treated and untreated potatoes.

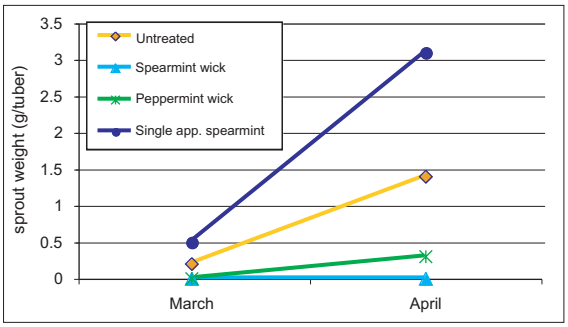

Figure 3. Mint Oils Sprout growth of Russet Burbank potatoes after a single spearmint application in Jaunary or spearmint or peppermint wick applications at 2-week intervals beginning in January.

wick of absorbent material over the mint oil reservoir. This creates a large surface area saturated with the essential oil for quick volatilization and distribution throughout the bulk pile. Both peppermint and spearmint oil must be applied with a sufficient concentration of the volatilized oil in the atmosphere of the storage to damage the sprouts.

To achieve efficacy, mint oil applications should be approximately 100 ppm per month with reapplication necessary every two to three weeks, or on a daily basis (Figure 2). That is equivalent to 10 lbs of oil per 1000 cwt potatoes (1 lb oil/5 ton) per month in applications of 50 ppm every two weeks, 75 ppm every three weeks, or a daily application of 4 ppm. In large potato storages, it will be necessary to close fresh air inlets and recirculate the storage air for one to two days. Frequent, repeated applications are necessary for adequate long-term sprout control. Figure 3 shows the enhanced sprouting that can occur after a single mint oil application, demonstrating the importance of repeated applications.

Both peppermint and spearmint oils were equally effective sprout suppressants, but peppermint oil caused fewer problems with culinary and palatability concerns (Table 2). Mint oil applications did not cause any significant processing quality changes such as altering tuber sugar profile or fry-color.

Table 2. Mint Oils Flavor, texture, color, and overall ratings are listed for Russet Burbank potatoes held in storage at 45°F for 9 months using mint oils or CIPC for sprout control. Lower numbers indicate less desirable quality. Values in the same column followed by the same letters are not significantly different.

	Flavor	Texture	Color	Overall
CIPC	6.4 A	6.6 A	6.8 A	6.4 A
Spearmint	5.1 B	6.2 A	6.7 A	5.3 B
Peppermint	6.1 A	6.3 A	6.7 A	6.2 A

Caution Use caution during application as essential oils are corrosive and may cause damage to metal and plastic. Skin contact should also be avoided.

Clove oil

Clove oil is also allowed for application to certified organic potatoes in storage. A commercially available clove oil is marketed as Biox-C in the United States by Pace International of Seattle. Check with your organic certification agency regarding the use of this product on certified organic potatoes. Our studies show that clove oil has good sprout control properties if applied on a regular basis (Figure 4).

A wick application method is not recommended with this product. It is a more effective sprout suppressant when applied as a thermal aerosol. It is recommended to have Biox-C applied professionally by a commercial sprout inhibitor applicator. Application rates for clove oil vary, but the initial application should be at least 5.2 lb/1000 cwt (0.52 lb product/5 ton). Similar to mint oils, repeated applications are necessary in two to three week intervals.

Hydrogen peroxide

The application of hydrogen peroxide to organic produce is also allowed by the National Organic Program standards. However, some hydrogen peroxide products contain adjuvants that are not allowed on organic produce. These products are labeled for application through the humidification system in potato storage. Similar to the essential oils, hydrogen peroxide physically damages or burns the developing sprout (Figure 5). Frequent and repeated applications are necessary for long-term sprout control. Otherwise sprouting can be enhanced with less frequent applications. This material has not been tested for sprout suppression in large bulk storages in the United States.

Timing of application

Timing of application is critical with all the sprout suppressants described. These alternative sprout suppressants are most effective when applied at "peeping," or before sprouts are one-eighth of an inch long. Delay of application may result in sprout suppression failure. Application methods will need to be fine-tuned for individual growers, seasons, and cultivars. Some cultivars that sprout rapidly and vigorously, such as Russet Norkotah, may not respond well to these alternative sprout control methods. Cultivars need be assessed on an individual basis for proper timing and frequency of application.

Additional considerations

There may be some additional benefits to using these products beyond sprout suppression. Clove oil, mint oils, and hydrogen peroxide have been shown to reduce pathogens in laboratory studies. The reduction of pathogen numbers may not result in a reduction of disease in storage. However, clove oil, when applied frequently, reduced the incidence and severity of silver scurf on the surface of a tuber (Table 3).

Certified organic growers should always check with their organic certification agency and the National Organic Standards for current organic production regulations prior to utilizing these described organic and alternative sprout control products.

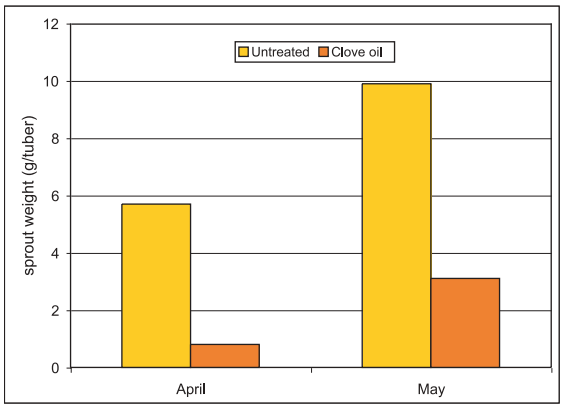

Figure 4. Clove Oil Compare sprout growth of untreated Russet Burbank potatoes and potatoes treated with multiple applications of clove oil—at 3-week intervals: 8 applications were made by the April sampling date and 9 applications by the May date. Initial clove oil rate was 5.2 lb/1000 cwt; subsequent rates were 1.9/1000 cwt.

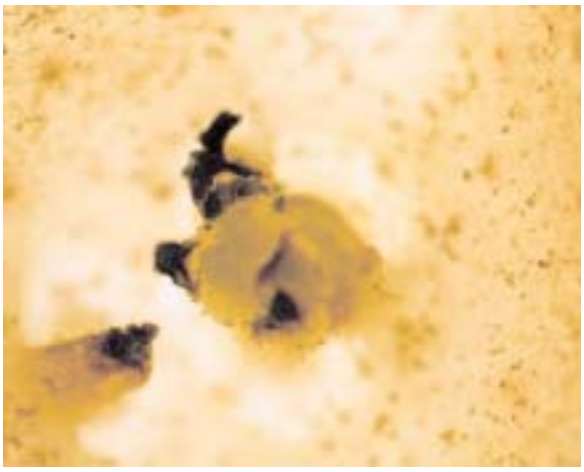

Figure 5. Hydrogen Peroxide Photomicrograph of sprout damage due to hydrogen peroxide is magnified 35 times.

Table 3. Clove Oil Silver scurf disease incidence is compared in Russet Burbank potatoes after 9 months of storage and 9 clove oil applications. Values in the same column followed by the same letters are not significantly different.

Treatment	Initial rate	Subsequent rate	Silver scurf incidence (%)
Untreated	-	-	98 A
Clove oil	5.2 lb/1000 cwt	1.9 lb/1000 cwt	78 B
Clove oil	10.5 lb/1000 cwt	3.7 lb/1000 cwt	61 C

Additional resources

Kleinkopf, G. and N. Olsen. 2003. Storage Management. *In* Potato Production Systems (*eds* J. Stark and S. Love.). Pp. 363-380.

Kleinkopf, G.E., Oberg, N.A. and N. L. Olsen. 2003. Sprout Inhibition in Storage: Current Status, New Chemistries and Natural Compounds. Amer J of Potato Res. 80:317-327.

About the authors

Mary Jo Frazier is a support scientist and Gale Kleinkopf is a research professor of plant science, now emeritus, both at the UI Kimberly Research and Extension (R&E) Center. Nora Olsen is an extension potato specialist at the UI Twin Falls R&E Center. Their e-mails, respectively, are frazier@kimberly.uidaho.edu, kleinkop@kimberly.uidaho.edu, and norao@uidaho.edu.

For Further Reading

You may order this or other publications about potatoes and other crops in Idaho from the University of Idaho Extension office in your county, or from CALS Publications, PO Box 442240, University of Idaho, Moscow, ID, 83844-2240, phone 208/885-7982, fax 208/885-4648, e-mail *calspubs@uidaho.edu* or browse the catalog and order online at *http://www.info.ag.uidaho.edu*. Prices below do not include state tax, shipping and handling.

Book — *Potato Production Systems* edited by Jeffrey C. Stark and Stephen L. Love, 420 pages, over 350 color photos. 2003. University of Idaho Extension. $89.95 soft cover; $109.95 hard cover.

BUL 839 — *Storage Management for Umatilla Russet Potatoes* by Tina L. Brandt, Gale Kleinkopf, Nora Olsen, and Steve Love. 2003. University of Idaho Extension. $3. Free online at *http://info.ag.uidaho.edu/pdf/BUL/BUL0839.pdf*.

CIS 1104 — *Managing Foreign Material for Quality Idaho Potatoes* by Nora Olsen and Brad Geary. 2002. University of Idaho Extension. 50-cents.

CIS 1110 — *Specialty Potato Production and Marketing in Southern Idaho* by Nora Olsen, Jo Ann Robbins, Tina Brandt, Rhea Lanting, Joan Parr, Cammie Jayo, and Christi Falen. University of Idaho Extension. $1.25. Free online at *http://info.ag.uidaho.edu/pdf/CIS/CIS1110.pdf*.

CIS 1118 — *Storage Management for Gem Russet Potatoes* by Tina L. Brandt, Gale Kleinkopf, Nora Olsen, and Stephen Love, 2004, University of Idaho Extension. $3. Free online at *http://info.ag.uidaho.edu/pdf/CIS/CIS1118.pdf*.

CIS 1119 — *Vine Kill and Long-term Storage of Ranger Russet Potatoes* by Lynn Woodell, Nora Olsen, Tina L. Brandt and Gale Kleinkopf. 2004. University of Idaho Extension. $3. Free online at *http://info.ag.uidaho.edu/pdf/CIS/CIS1119.pdf*.

Video 918 — *Continuing to Manage Foreign Material for Quality Idaho Potatoes*. 2002. University of Idaho Extension. A Spanish version follows the English version. Length: English 19:41 mins., Spanish 23:36 mins. Order #7073. $35.

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