

ALTERNATIVE SPROUT SUPPRESSANTS FOR STORED POTATOES

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BACKGROUND

Chlorpropham (CIPC) has been in use in the potato industry for many years and is currently the principal sprout suppressant for long-term storage. Although CIPC is highly effective and relatively safe sprout inhibitor, alternative sprout suppressants would be desirable for the industry especially in export markets where CIPC is not allowed. Federally funded research has identified many volatile oils that are active as potato sprout suppressants. The staff at the Kimberly R&E Center Potato Research Facility has worked for several years on testing the effectiveness of alternative sprout suppressants and application methods. Some of the alternatives under investigation are spearmint oil, peppermint oil, eugenol (an extract of clove oil), and hydrogen peroxide. Recently, as a result of this work, a new product, Biox A (eugenol), has been registered for sprout control in Idaho, Washington, Oregon, Colorado, California, Texas, and Florida. This product has also received approval for use in the organic market.

When evaluating sprout suppressants many quality aspects are also tested because even a highly effective product will not be accepted if it causes potatoes to be unusable for processing or fresh market. Sprout length, weight and rating, sugar content, fry color, disease suppression, wound healing, and taste are some of the parameters tested. Application methods have also been investigated. CIPC is normally applied as a thermal aerosol. This hot aerosol can be circulated through the potato pile without disturbing the pile and will efficiently distribute the chemical to the surface of the potato. Since this method of application is the standard in the industry, initial tests of volatile oil application were as a thermal aerosol. Other methods of application such as cold aerosol and wick volatilization were subsequently tested.

Because CIPC works by inhibiting cell division, generally only one application is necessary for long-term sprout control. However, most alternatives work by physically destroying sensitive sprout meristem tissue so multiple applications are necessary for long-term control. Alternatives must be applied every two to three weeks after dormancy break or may be wicked into the storage atmosphere on a continuous basis.

RESULTS

Spearmint and peppermint

Sprout control was most effective when the mint oils were applied with the wick method (Fig 1). Uniform air distribution is necessary for consistent sprout control. When containers were ventilated (Fig. 2) control was less effective but with the daily application still adequately effective.

Biox A

Sprouting evaluations (Fig. 3), sugar analysis, and fry color monitoring were conducted on tubers treated with several rates of Biox A, an untreated control, and a CIPC treated control. Initial Biox

Applications were made on December 13, 2000. Subsequently, applications were made every three weeks until the final application on May 10, 2001. Treatment rates for Biox A were 90 ppm followed by 30 ppm (label rate), 90 ppm, 180 ppm, and an application of label rate using a thermal (hot plate) applicator similar to the type used to apply CIPC. Good sprout suppression was achieved with all Biox A treatments (Fig.3).

Hydrogen peroxide

MCW-100 (stabilized hydrogen peroxide) was tested as a sprout control agent against an untreated and a CIPC-treated control. The product was applied with the Tabor humidity nozzle from Optiguide at 16 ppm. Initial application was on January 3, 2001, and applications were repeated every three weeks until the final application on March 28, 2001. After March 14, sprout length was significantly increased by MCW-100 treatment. There appeared to be some damage to sprouts early in the season causing multiple sprouts in each eye. Later treatments were not effective. The chemical company recommends applying the chemical in a manner that produces condensation on the potatoes. Condensation was not achieved in these applications potentially reducing the effectiveness of the treatments. However, the advisability of creating condensation in the pile may be questionable. Since some damage to sprouts was observed in this study the practice of applying hydrogen peroxide to seed needs reevaluation.

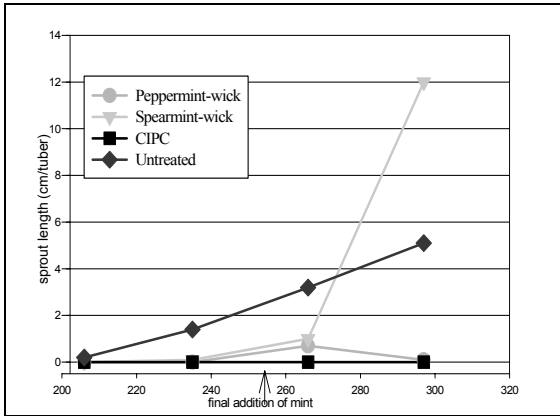


Fig.1 Sprout length in mint-treated tubers

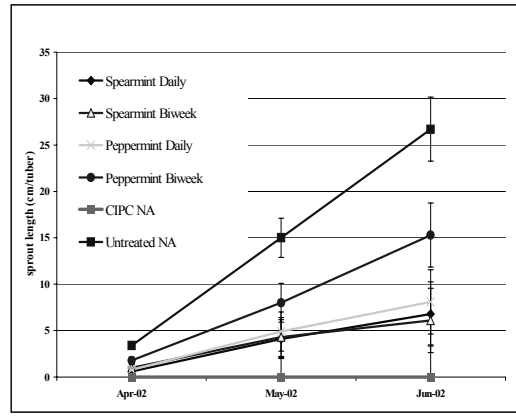


Fig. 2 Sprout length in mint-treated tubers-ventilated

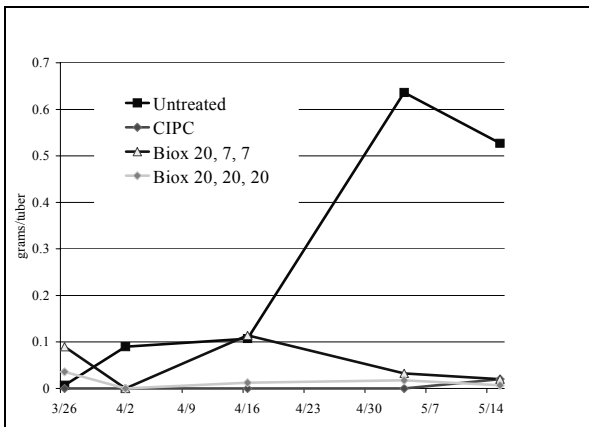


Fig 3. Sprout length in Biox A-treated tubers

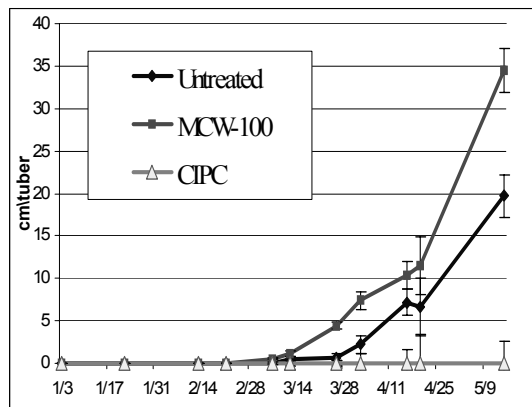


Fig. 4 Sprout length in MCW-100-treated tubers

Glucose/sucrose concentrations (on a percent fresh weight) and fry color were not severely impacted by any of the alternative sprout suppression applications (Tables 1, 2, and 3). In some cases, significant differences were noted but this may have been due to sampling variability and

was not consistent for any treatment. These slight increases would not be serious enough to warrant rejection of the lot by processors.

Table 1. Glucose and sucrose concentration (% fresh weight) and photovolt reflectance of fry color (Photo volt) for tubers treated with **spearmint and peppermint** from three sampling dates.

Treatment	Rate ppm/ month	Wick Applic	April 6			May 4			June 1		
			Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt
Spearmint	100 ppm	Daily	0.059	0.094	35.0	0.057	0.079	37.1	0.045	0.077	39.6
Spearmint	100 ppm	Biweek	0.051	0.076	35.2	0.056	0.072	38.6	0.056	0.067	38.3
Peppermint	100 ppm	Daily	0.058	0.071	34.1	0.046	0.071	38.5	0.054	0.053	36.5
Peppermint	100 ppm	Biweek	0.052	0.083	38.0	0.047	0.071	41.8	0.047	0.062	41.9
CIPC	22 ppm	NA	0.050	0.070	40.1	0.039	0.062	40.4	0.033	0.064	43.2
Untreated	NA	NA	0.061	0.073	37.4	0.046	0.057	43.2	0.044	0.057	40.5
LSD			ns	0.008	4.0	0.013	0.014	3.6	0.013	ns	3.2

Table 2. Glucose and sucrose concentrations (% fresh weight) and photovolt reflectance (%) of fry color (Photo volt) for tubers treated with **Biox A** from three sampling dates.

Treatment (ppm)	April 3			May 8			June 5		
	Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt
Untreated	.056	.059	42	.040	.064	*	.047	.066	44
CIPC	.055	.073	43	.036	.071	*	.055	.067	41
Biox A 90,30,30	.063	.065	42	.075	.071	*	.065	.068	41
Biox A 90,90,90	.063	.055	40	.064	.070	*	.096	.074	37
Biox A 180,180,180	.059	.063	45	.066	.072	*	.070	.069	40
Biox A 90,30,30 Thermal app	.043	.060	44	.060	.072	*	.066	.069	40
LSD	Ns	Ns	Ns	.022	Ns	Ns	Ns	Ns	4

* USDA fry color available for May 8 sampling date only.

Table 3. Glucose and sucrose concentrations (% fresh weight) and photovolt reflectance (%) of fry color (Photo volt) for tubers treated with **MCW-100** from three sampling dates.

Treatment	March 27			April 24			May 30		
	Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt	Gluc. % FW	Suc. % FW	Photo volt
Untreated	.055	.059	42	.049	.054	44	.042	.047	39
MCW-100	.033	.055	42	.043	.056	44	.035	.045	43
CIPC	.043	.066	41	.041	.065	44	.051	.049	42
LSD	Ns	.004	Ns	Ns	.007	Ns	Ns	Ns	Ns

After 9 months in storage, a professional taste panel was used to test baked potatoes, which had received a total of 400-ppm mint oil in wick applications. This test was conducted one week after a 50 ppm treatment had been applied. This sampling time was chosen as a worst case scenario. It is unlikely a grower would market potatoes so soon after treatment. The taste panel rated spearmint treated tubers significantly lower than CIPC-treated or peppermint-treated potatoes in flavor (Table 4). No differences in color or texture were detected. A taste test of Biox A-treated tubers has not yet been completed.

Table 4. Results of a taste test comparing potatoes that received 400 ppm mint oils to CIPC treated potatoes.

	Flavor	Texture	Color	General
CIPC	6.4 A	6.6	6.8	6.4 A
Spearmint	5.1 B	6.2	6.7	5.3 B
Peppermint	6.1 A	6.3	6.7	6.2 A
LSD	0.6	Ns	Ns	0.5

The cost of sprout suppression with mint oil (Table 5) and Biox A (Table 6) was estimated.

Table 5. Cost of sprout control (\$/100 lbs.) with mint oils based on a range of oil prices.

Oil price \$/LB	Number of 100 ppm applications					
	1	2	3	4	5	6
\$7.00	0.07	0.14	0.21	0.28	0.35	0.42
\$8.00	0.08	0.16	0.24	0.32	0.40	0.48
\$10.00	0.10	0.20	0.30	0.40	0.50	0.60
\$15.00	0.15	0.30	0.45	0.60	0.75	0.90

Table 6. Cost of sprout control (\$/100 lbs.) using Biox A based on a price of \$121/gallon

Number of applications and rate						
1 (90 ppm)	2 (30 ppm)	3 (30 ppm)	4 (30 ppm)	5 (30 ppm)	6 (30 ppm)	
.10	.13	.17	.20	.23	.27	

Disease suppression studies

Biox A was evaluated using amended media studies for disease suppression. In the laboratory, Biox A was shown to be an effective suppressant of fungal pathogens (Table 7). The estimated dose of the chemical necessary to suppress the pathogen by 50% (ED50) was calculated. The ED50 for all fungal pathogens was near or below the initial label rate (90 ppm) for sprout suppression. *Helminthosporium solani* (silver scurf) spores were suppressed at a concentration of 152 ppm. Erwinia was not significantly impacted by Biox A. Tests of disease suppression directly on tubers were not as successful. Fusarium dry rot was not significantly reduced by Biox A treatment. Silver scurf spore germination was reduced by 24% when the label rate of Biox A was applied as an aerosol.

Table 7. In vitro disease evaluations using Biox A.

Potato pathogen	ED50*
<i>Rhizoctonia solani</i>	55
<i>Alternaria solani</i>	67
<i>Fusarium sambucinum</i>	85
<i>Fusarium coeruleum</i>	80
<i>Helminthosporium solani</i>	106
<i>Helminthosporium solani</i> spores	152
<i>Erwinia carotovora sp. carotovora</i>	Ns

*ED50 is defined as the concentration of chemical (ppm) at which 50% of the pathogen is removed, inhibited, or killed. Ns = not significantly impacted.

CONCLUSIONS

Spearmint oil, peppermint oil, or Biox A could be effectively used for potato sprout suppression. MCW-100 was not as successful but may be more effective at higher rates. For successful long-

term storage, multiple applications of any of the alternatives are necessary. For mint oils, application by the wick method is preferred, but any method that would allow the oil vapor to remain in the storage atmosphere over time and could be repeated in biweekly intervals could be used. The preferred method of application for Biox A is with the Xeda Electrofog applicator. Applications should begin after the end of dormancy when potatoes are initiating sprouting. The cost of sprout suppression will vary with the number of applications necessary. If the intended length of storage is longer than one month past dormancy break, cost will be significantly higher than with CIPC.