

CLOVE OIL FOR POTATO SPROUT AND SILVER SCURF SUPPRESSION IN STORAGE

Mary Jo Frazier, Gale E. Kleinkopf, and Nora Olsen

As part of an ongoing project to test alternative sprout suppressants, clove oil (60% eugenol, Biox-C) was tested in several experiments over four years. Eugenol (99%, Biox-A) was also compared in some studies. The primary objective of the studies was to control potato sprouting in long-term storage and a secondary objective was to evaluate clove oil effects on silver scurf.

Clove oil and eugenol's mode of action is physical damage to the sensitive sprouting tissue. Since only the exposed sprout is damaged, new sprout development will not be affected and repeated applications will be required. The chemical is very volatile and dissipates with little or no residue.

Studies were conducted on 'Russet Burbank' potatoes stored at 45°F unless otherwise stated. Applications of eugenol (90 ppm ai followed by 6 repeated applications of 30 ppm ai in three week intervals) made with a "gun" applicator (Xeda) or with a thermal aerosol applicator, controlled sprouting in long-term storage (Fig. 1). In another study, gun applications (90 ppm ai followed by 5 repeated applications of 30 ppm ai) made to 1-ton boxes of potatoes significantly increased sprout length (Fig. 2). After the initial application damaged the sprout in each eye, secondary sprouts formed in each eye resulting in multiple sprouts per eye. Wick application was not an effective method of application (Fig. 3). Two rates of clove oil (67 ppm initial, then 23 ppm repeated; 134 ppm initial, then 46 ppm repeated) and two rates of eugenol (55 ppm initial, then 20 ppm repeated; 110 ppm initial, then 40 ppm repeated) were compared in thermal aerosol applications made to 1-ton boxes. After seven applications, sprout weight was significantly reduced when evaluated on two dates approximately 210 and 240 days after harvest (Fig. 4).

Sprout control with clove oil was evaluated on shorter dormancy varieties (Chipeta and Russet Norkotah) in a test using thermal aerosol in 1-ton boxes. After six months of storage at 45°F sprout weight was significantly reduced by seven clove oil applications in three week intervals (Table 1).

Sugar concentrations (Fig. 5) and fry color (data not shown) were not affected by eugenol applications. In a baked potato taste test clove oil or eugenol treated potatoes were not rated significantly different in taste or other parameters from the CIPC standard (Table 2).

In the laboratory, *in vitro* screening of some common potato pathogens on eugenol amended media determined the concentration of eugenol necessary to inhibit or kill 50% of the pathogen (ED50) (Table 3). The ED50 for *Helminthosporium solani*, the causal organism of the silver scurf disease, was estimated to be near the rates used for sprout control. It was also demonstrated that aerosol eugenol applications reduced germination of *H. solani* spores by approximately 30 %. To test the effectiveness of eugenol and clove oil for silver scurf suppression, tuber samples naturally infected with silver scurf were included in the boxes receiving the thermal aerosol treatments. In the first year of the study no significant difference in silver scurf incidence or severity with eugenol applications was seen (Table 4). When the experiment was repeated, conditions in the boxes were managed to promote silver scurf infection by weekly addition of simulated condensation. After 8 months of storage, evaluation for silver scurf control showed significant reductions in disease severity rating and incidence when infected tubers were treated with eugenol or clove oil (Table 5). In another study, clove oil and eugenol showed no significant control of Fusarium dry rot (data not shown).

Fig. 1. Eugenol applications with gun or thermal aerosol applications on Russet Burbank

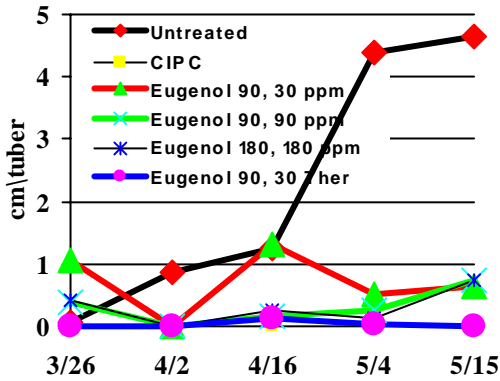


Fig. 3. Wick application of clove oil and eugenol on Russet Burbank

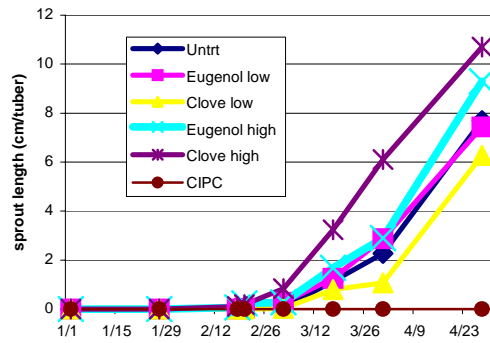


Fig. 2. Gun applications of clove oil and eugenol in 1-ton box study

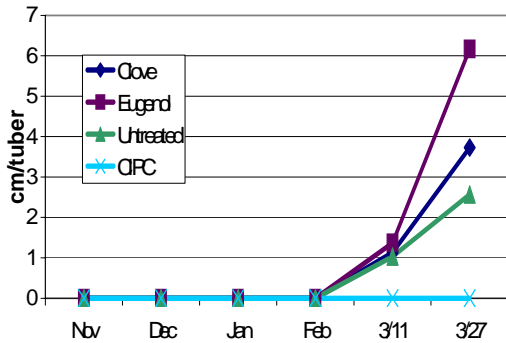


Fig. 4. Thermal aerosol application of clove oil or eugenol

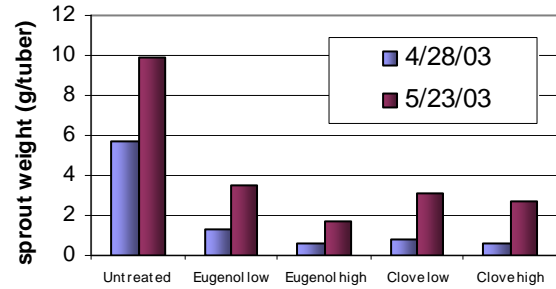


Table 1. Sprout weight (g/tuber) for two cultivars after seven thermal aerosol applications of clove oil and six months of storage at 45°F.

	<i>Russet Norkotah</i>	<i>Chipeta</i>
Clove oil	9.9 A	2.8 A
Untreated	18.7 B	4.1 B

Values in the same column followed by the same letters are not significantly different

Fig. 5. Glucose concentration in tubers treated with multiple applications of eugenol

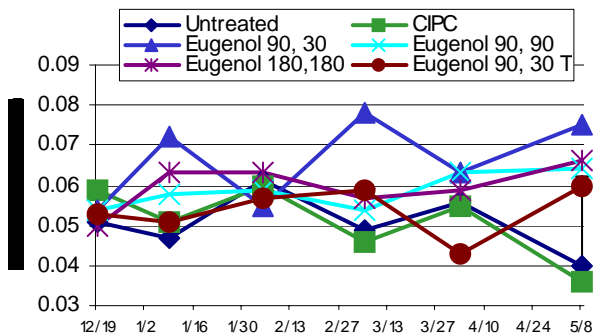


Table 2. Taste test comparisons with clove oil or eugenol and a CIPC treated standard

Treatment	Color	Texture	Flavor	General
Clove oil	6.9 A	6.3 A	6.2 A	6.1 A
Eugenol	6.9 A	6.2 A	6.0 A	6.2 A
CIPC	6.9 A	6.2 A	6.3 A	6.2 A

Values in the same column followed by the same letters are not significantly different ($\alpha=0.05$)

Table 3. ED50* for eugenol on potato pathogens

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>	No effect

*ED50 is defined as the estimated concentration of chemical (ppm) at which 50% of the pathogen is inhibited or killed.

Table 4. Silver scurf disease severity and incidence after six months of storage and six applications.

Treatment	Rate	Severity rating**	Incidence %
Untreated	NA	2.0 A	67 A
Biox-C	5.2 lb/1000 cwt, then 1.9 lb/1000 cwt	1.9 A	53 A
Biox-A	4.5 lb/1000 cwt, then 1.6 lb/1000 cwt	1.9 A	53 A

**Disease severity rating based on a scale of 1-4: 1=no infection, 2=slight infection, 3=moderate, 4=heavy infection

Values in the same column followed by the same letters are not significantly different ($\alpha=0.05$)

Table 5. Silver scurf disease severity and incidence after nine months of storage and nine Biox applications.

Treatment	Rate	Severity rating**	Incidence %
Untreated	NA	3.3 A	97.5 A
Biox-A low	4.5 lb/1000 cwt, then 1.6 lb/1000 cwt	2.8 B	83.3 B
Biox-C low	5.2 lb/1000 cwt, then 1.9 lb/1000 cwt	2.6 BC	77.5 B
Biox-A high	9.1 lb/1000 cwt, then 3.2 lb/1000 cwt	2.2 CD	64.2 C
Biox-C high	10.5 lb/1000 cwt, then 3.7 lb/1000 cwt	2.2 CD	60.8 C

**Disease severity rating based on a scale of 1-4: 1=no infection, 2=slight infection, 3=moderate, 4=heavy infection

Values in the same column followed by the same letters are not significantly different ($\alpha=0.05$)

DISCUSSION

Clove oil can be used effectively for potato sprout control but multiple applications at three week intervals will be required for long-term sprout suppression. The sprout suppressant properties of clove oil are ideal for an organic crop or a crop destined for export to a country that does not allow CIPC. Another use for this product may be to remove sprouts if a failure of traditional sprout control methods has occurred. Clove oil rates, timing of application, number of applications, application methodology and cultivar selection need to be integrated for effective use of this product for sprout control.