METHODS FOR SPROUT AND DISEASE SUPPRESSION OF POTATOES IN STORAGE

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The potato industry in the United States is highly dependant on chlorpropham for sprout inhibition. Although the registration of this chemical is not in jeopardy currently, with enactment of the Food Quality Protection Act the indefinite use of chlorpropham is questionable. Alternative methods of potato sprout inhibition should be investigated to reduce the industry's dependence on this single compound

High-energy electron acceleration treatment of tubers was evaluated for sprout suppression and quality aspects. Methods of decreasing reducing sugars after irradiation treatments were evaluated. A third year of data was collected on the efficacy of Biox-A (eugenol) and Biox-C (clove oil) products as alternative sprout suppressants. The use of Biox to suppress the silver scurf disease in storage was also evaluated.

HIGH-ENERGY ELECTRON TREATMENT

Potatoes were harvested September 18, 2002 and treated within three days of harvest. Treatments were applied with a high-energy linear accelerator at rates of 25 Gy (10 Gy = 1 krad/kg food) and 50 Gy. Each treatment had a paired control. A dose-rate experiment evaluated treatments made by manipulating the intensity of the irradiation while holding the dose at 25 Gy. Initial sugar analysis and fry-color samples were evaluated after one week in storage. Fry-color monitoring was conducted on the same samples as were used for sugar extraction. Fry-color was measured using a Photovolt ® Reflection Meter Model 577. Tuber respiration rates were also measured after three weeks in storage. After three months in storage samples were split and a sub-sample was stored at 58°F for reconditioning. Sugar analysis and fry-color determinations were performed after two and four weeks of reconditioning. Sprouting and other quality evaluations were made on the cold storage samples throughout the remainder of the storage season.

Sub-samples were also evaluated for susceptibility to soft rot (*Erwinia* spp.; by Dr. Terry Miller) and dry rot (*Fusarium* spp.). Soft rot sub-samples were placed in a mist chamber at 55°F and evaluated after one month. Dry rot sub-samples were held at 45°F and evaluated after 5 months in storage. Tubers were not inoculated in either study.

There were no significant differences in respiration rates between the treated potatoes and paired controls measured after three weeks in storage (Table 1). However, there was a trend ($p=0.10$) for higher respiration rates in the 50 Gy treatment and paired control tubers compared to the 25 Gy treatment and paired control. In the dose-rate experiment respiration was increased in the slow treatment but was not in the fast treatment (Table 2).

Table 1. Respiration rates in treated tubers after three weeks in storage.

Treatment Rate Gy	Respiration rate mg/kg/hr
0	4.8
25	8.9
0	9.2
50	10.4
LSD .05	NS
LSD .010	4.2

Table 2. Respiration rates in dose-rate treated tubers after three weeks in storage.

Treatment Rate Gy	Respiration rate mg/kg/hr
0 slow	1.7
25 slow	8.0
0 fast	7.3
25 fast	5.9
LSD .05	4.7

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High-energy treatments (50 Gy) were effective in controlling sprouting at 45°F storage throughout the duration of the study (Fig. 1). The 25 Gy rate showed some sprouting characterized by multiple sprouts in some of the eyes. The 25 Gy treatment was still significantly less sprouted than the paired control. Sprouting in the dose-rate study was similar to the 25 Gy treatment.

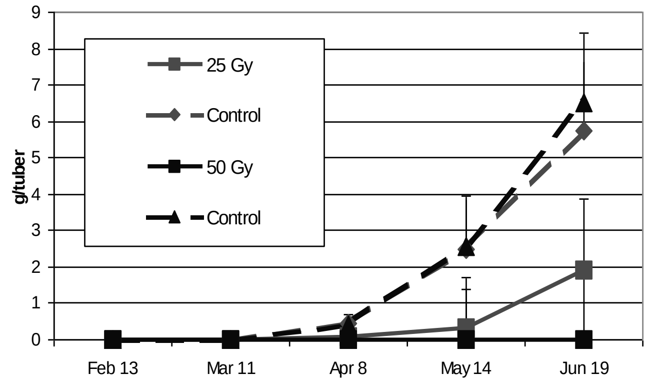

Fig. 1. Sprout weight (g/tuber) in irradiated and untreated tubers on 5 dates

Both high-energy treatments in the dose study increased glucose significantly compared to the paired controls (Fig. 2). Over time, the tubers were able to re-condition even in 45°F storage. After mid-February glucose levels were not significantly different between any of the treatments. Reconditioning at 58°F was effective in reducing glucose levels by approximately 0.01% per week (data not shown). After 2 weeks of reconditioning, glucose concentration in tubers treated with 25 Gy was not significantly different from the untreated control held at 45°F. After four weeks of reconditioning, both the 25 and 50 Gy samples were not significantly different in glucose concentration than the untreated samples at 45°F.

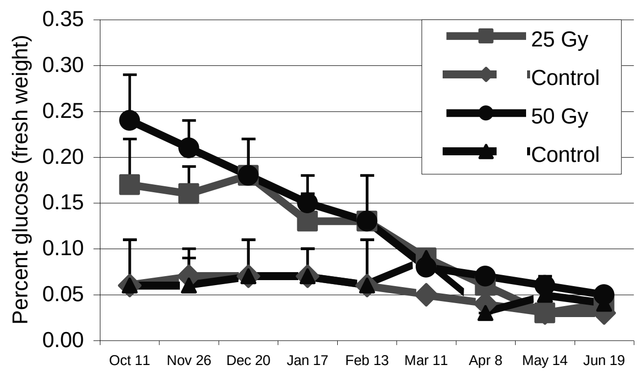

Fig. 2. Glucose concentration of irradiated and untreated potatoes throughout the storage season.

In the dose-rate study, glucose concentration for the high-energy treatment applied at the fast dose-rate was not significantly different from the paired control (Fig. 3). In comparison, the glucose concentration for tubers treated with the slow dose-rate was significantly higher than the paired control.

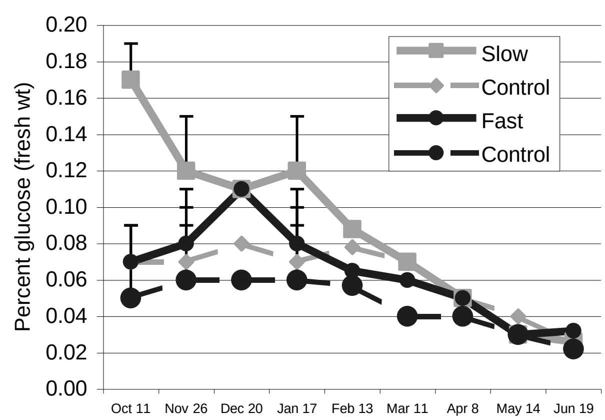

Fig. 3. Glucose concentration in potatoes treated with various dose-rates and their paired controls.

Fry-color evaluations mirrored the glucose data for both studies. In general, higher measurable glucose concentration equated to measurably darker fry-color. Immediately after treatment, all high-energy treatments except the fast dose-rate treatment resulted in fry-color unacceptable to processors (data not shown). Fry-color improved to acceptable levels with time in storage or with reconditioning at 58°F. After six months of storage (45°F), fry-color for the 25 Gy treatment and the 50 Gy treatment were in the acceptable range.

Tuber rot potential was not impacted by the high-energy treatments (Table 3). There was a trend (p=0.10) for increased dry rot in the 50 Gy reconditioned treatment. There was insufficient soft rot development for a valid test. Suberization was impacted by the amount of tumbling the treatments received but not by the high-energy treatments (data not shown). Shrinkage was not impacted by the high-energy treatments (data not shown).

Table 3. Dry rot potential in treated and untreated tubers.

Rate (Gy)	% issue infection	Dry rot incidence (%)
0	0.8	20.0
25	1.4	13.3
0	0.1	3.3
50	1.7	16.7
0 reconditioned	0.4	13.3
25 reconditioned	0.3	13.3
0 reconditioned	0.9	13.3
50 reconditioned	1.9	33.3
LSD (.05)	NS	NS
LSD (.10)	NS	15.9

BIOX

Biox-A (eugenol) or Biox-C (clove oil) was applied in nine applications at three-week intervals using a hot aerosol applicator. The first application was made on December 12, 2002. Acceptable sprout control was achieved in this study with both Biox treatments at the high rates (Table 4)(See Table 5 for rates). In a second study using a wick application method, sprout growth was not controlled with Biox-A, Biox-C, or sagebrush oil (*Artemisia tridentate*) (data not shown). Hot aerosol application method appears to be a more effective means for applying this product. Samples infected with silver scurf (*Helminthosporium solani*) were included in the boxes receiving the hot aerosol treatments. These 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 Biox-A or Biox-C (Table 5).

Table 4. Mean sprout rating*, sprout length and sprout weight per tuber of potatoes treated with Biox.

	April 28, 2003			May 23, 2003		
Treatment/rate	Sprout rating*	Sprout length (cm)	Sprout weight (g)	Sprout rating*	Sprout length (cm)	Sprout weight (g)
Untreated	4.0	16.3	5.7	4.0	27.9	9.9
Biox-A low	3.9	4.9	1.3	3.9	10.2	3.5
Biox-C low	3.7	3.0	0.8	3.9	9.8	3.1
Biox-A high	3.8	3.1	0.6	3.9	6.1	1.7
Biox-C high	3.6	2.8	0.6	3.8	7.4	2.7
LSD (.05)	0.1	3.4	1.2	NS	5.7	2.2

* Sprout rating based on a scale of 1-4:1= no sprouting, 2= "peeping", 3= sprout < .5 cm, 4= sprout > .5 cm

Table 5. Silver scurf disease severity and incidence after nine months of storage and 9 Biox applications.

Treatment	Rate	Severity rating**	Incidence %
Untreated	NA	3.3	97.5
Biox-A low	4.5 lb/1000 cwt, then 1.6 lb/1000 cwt	2.8	83.3
Biox-C low	5.2 lb/1000 cwt, then 1.9 lb/1000 cwt	2.6	77.5
Biox-A high	9.1 lb/1000 cwt, then 3.2 lb.1000 cwt	2.2	64.2
Biox-C high	10.5 lb/1000 cwt, then 3.7 lb/1000 cwt	2.2	60.8
LSD (.05)		0.4	10.6

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

DISCUSSION

The use of a high-energy linear accelerator appears to be a valid alternative for potato sprout control. This research has shown that by reducing the dose and/or the dose-rate, problems associated with the treatment can be avoided. This technology could be developed for commercial sized applications and provide an effective means of sprout control with no reside concern. Biox-C has recently been approved for application to potatoes and is currently being used on a limited scale in the potato industry.