Reducing Postharvest Losses and Wastage in

UK Potato Storage due to Sprouting

Objective 4

ALTERNATIVE SPROUT SUPPRESSANTS

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S438 (2010/11) **Date submitted: August 2011**

1. Introduction

After a period of dormancy, sprout growth is initiated in stored potatoes. Unchecked, sprout growth gives rise to changes in stored potatoes that ultimately render the crop unacceptable. Such changes include increased weight loss, shrinkage and deterioration in processing quality.

Suppression of potato sprout development during storage, especially at the warmer temperatures used for processing, is therefore critical. CIPC is the main active substance for the control of sprout growth, and in 2008 was used on around 47% of stored potatoes in Great Britain (Garthwaite *et al*. 2009[1]) and made up 94% of post-harvest treatments to stored potatoes.

Alternative sprout suppressants are being sought and treatments are becoming available. To date, only post-harvest treatment with ethylene (www.pesticides.gov.uk/approvals.asp?id=271) has had significant commercial success. It was used on 4% of stored crops in 2008 (Garthwaite *et al*. 2009). Treatments with ethylene currently are limited to the fresh potato sector, because of potential for deterioration in processing quality.

Essential oils have been recognised as sprout suppressants for many years and are available formulated as products for sprout control (and other applications) elsewhere.

The aim of this work, undertaken as an industry-focused objective (objective 4) of the Defra commissioned project '**Reducing postharvest losses and wastage in UK potato storage due to sprouting'** and funded by AHDB Potato Council, is to assess products that are close to the market (or are available elsewhere), for their potential sprout suppressant activity and market suitability.

[1] Garthwaite, D.G., I. Barker, G. Parrish and L. Smith, 2009. Pesticide usage survey report 227. Potato stores in Great Britain. Food & Environment Research Agency, York, UK. http://www.fera.defra.gov.uk

2. Materials and methods

Experimental work was conducted in eight 120 litre plastic chambers (Fig. 1), four chambers located in each of two stores which were operated at 6°C and 9°C. Netted samples of two cultivars (total weight 40 kg) were placed in the chambers which were sealed and ventilated, using a vacuum pump, to give 2 air exchanges per day. Clean air for ventilation was sampled from an adjacent store, and exhausted outside stores, to ensure no cross-contamination of treatments. Samples of the cultivars Russet Burbank and Saturna were used for the trial. Chambers were loaded, and initial applications made on 16 December 2010. Untreated samples (not in chambers) were held in separate stores, at similar temperatures.

Figure 1. Experimental store showing four chambers for assessment of alternative sprout suppressants

The treatments examined are shown in Table 1. CIPC (*GroStop Ready*) was applied at a nominal application rate of 18 g tonne^{-1} directly to tubers on a roller table using a *Microstat* ULV spinning disc applicator (Horstine Farmery, Gainsborough, UK) at store loading. The electrostatic function of the applicator was not used. No further applications of CIPC were made during storage.

Spearmint oil *(Biox-M)* was applied initially at a rate of 90 ml tonne^{-1}, followed by applications at 30ml tonne^{-1} at 21 day intervals.

Clove oil (*Biox-C*) was applied on four occasions. On the first two occasions at 48 ml tonne^{-1}. At the third application the rate was increased to 84 ml tonne^{-1}. At the final application of *Biox-C*, a rate of 84 ml tonne^{-1} was used and a fan was employed to recirculate applied mist through the crop.

Carvone (*Talent*) was applied at the proposed weekly application rate for *Talent* on ware potatoes (initially 30 ml/tonne, reducing to 15 ml/t).

Chemical treatments during storage were made with a pneumatic applicator (Badger, Franklin Park, IL., USA) through a port in the side of the chamber. Ventilation was discontinued for 24 hours following in-store treatments.

Table 1. Sprout suppressant products/formulations in study

active substance	formulation	supplier
CIPC	*GroStop Ready*	Certis Europe
spearmint oil	*Biox-M*	Xeda International
clove oil	*Biox-C*	Pace International
caraway oil (carvone)	*Talent*	Makhteshim Agan

Assessments were carried out in April and July after 16 and 29 weeks’ storage respectively. On the first sampling occasion sprout growth was assessed and at the second occasion sprout growth and processing quality.

3. Results

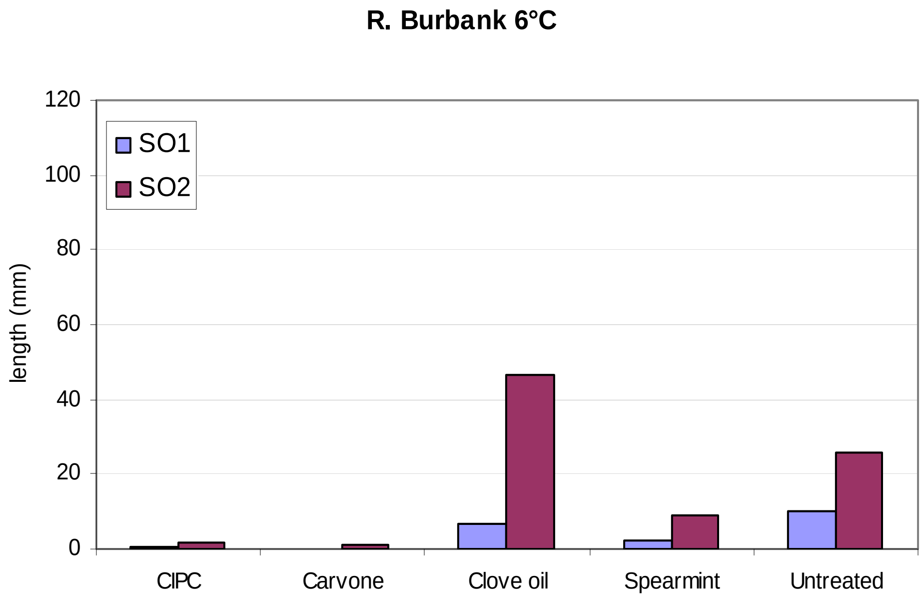
Results of sprouting assessments (mean maximum sprout length, mm) are shown in Figures 2 and 3 for cultivars Russet Burbank and Saturna respectively. In cultivar Russet Burbank sprouting was maintained at low levels during storage at 6°C using CIPC, caraway oil (carvone) and spearmint oil. Sprout control using clove oil was relatively poor, with sprout length excessive (>40mm) at store unloading.

During storage at 9°C only CIPC and caraway oil were effective at controlling sprout growth. Sprout growth of Russet Burbank was excessive at the first sampling occasion (sprout length >20mm) in treatments using spearmint oil and clove oil at 9°C.

In cv Saturna, sprout control was effective using CIPC, spearmint oil and caraway oil during storage at 6°C. Sprout length was excessive on both sampling occasion using clove oil at 6°C.

Results for Saturna mirrored those of cv Russet Burbank at 9°C, although control was not generally as effective. With cv Saturna at 9°C, only treatment with CIPC maintained sprouting at a low level (<10mm) at the end of storage.

Figure 2. Mean maximum sprout length (mm) of samples of cv Russet Burbank during storage at 6°C and 9°C.



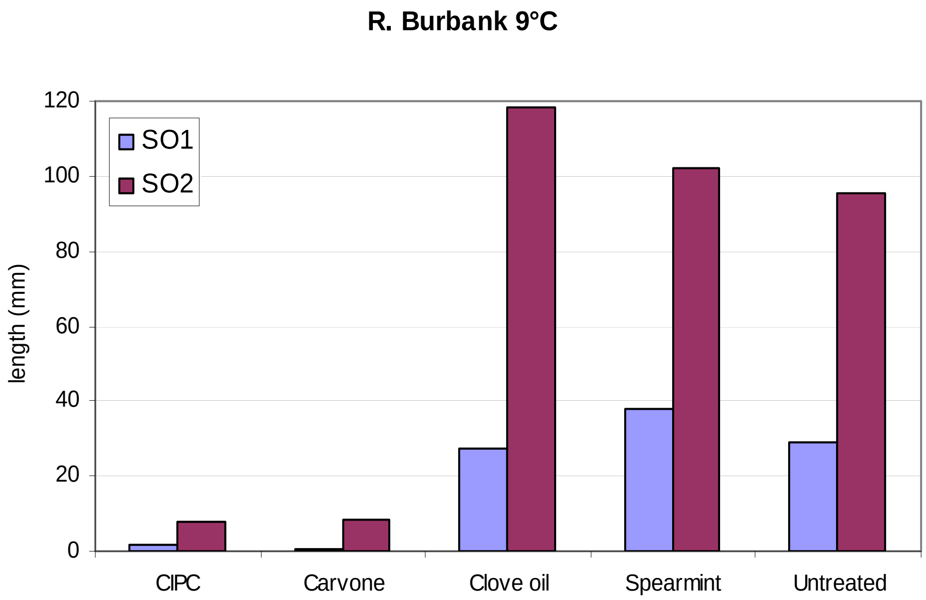
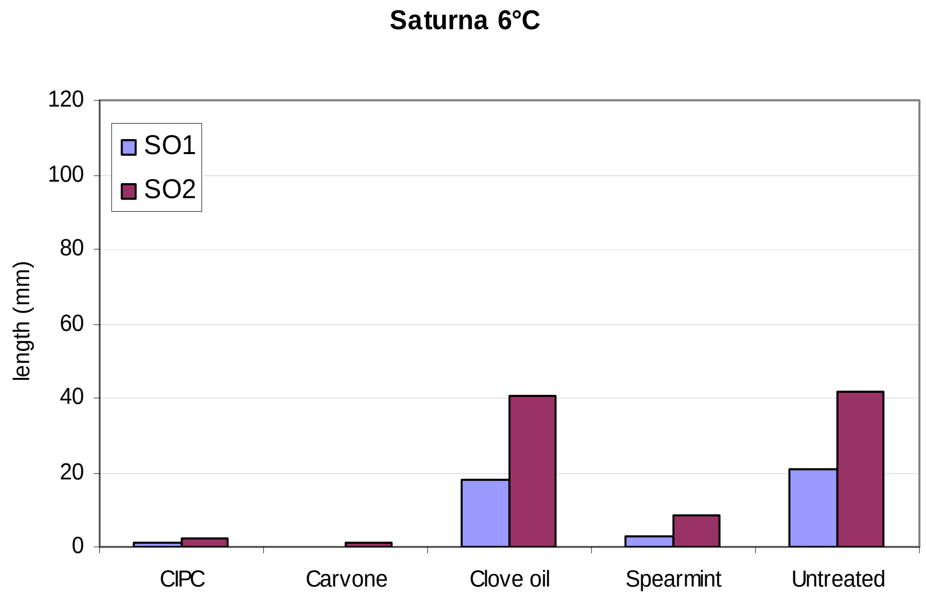
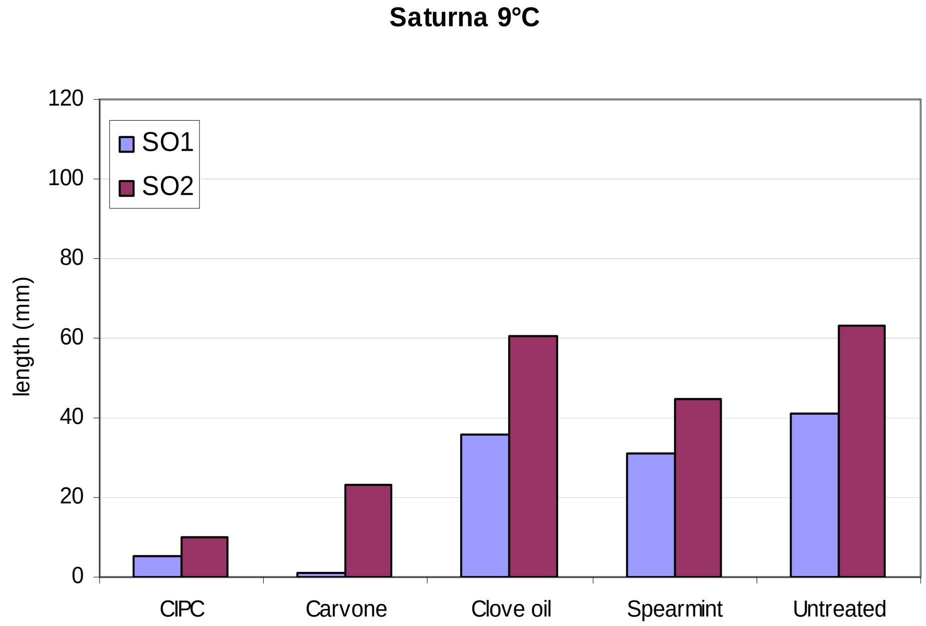


Figure 3. Mean maximum sprout length (mm) of samples of cv Saturna during storage at 6°C and 9°C.





Results of processing quality assessments are shown in Table 2 for cv. Russet Burbank. After long-term storage there were no differences in the fry colour of Russet Burbank, as a result of the different chemical treatments. Fry colour was generally lighter in samples held at the warmer storage temperature.

Table 2. Fry colour (SBCSR score*) of cv Russet Burbank processed as chips following storage at 6°C and 9°C.

treatment	store temperature	
	6°C	9°C
CIPC	4.7	3.5
Carvone	4.7	3.5
Clove oil	4.8	3.5
Spearmint	4.7	3.6
Untreated	4.5	3.3

Fry colour score conversion

*SBCSR	1	2	3	4	5	6	7
USDA	000	00	0	1	2	3	4

Results for processing quality assessments of cultivar Saturna are shown in tables 3 and 4 for fry defects and fry colour respectively. Following storage at 6°C only CIPC resulted in low and acceptable levels of fry defects (<10%). At 9°C, CIPC, together with caraway oil, resulted in high levels of fry defects and clove and spearmint oils resulted in relatively low fry defect levels.

Table 3. Fry defects (%) of cv Saturna processed as crisps following storage at 6°C and 9°C

treatment	store temperature	
	6°C	9°C
CIPC	9.2	28.5
Carvone	27.8	23.7
Clove oil	33.7	9.2
Spearmint	22.5	5.6
Untreated	15.3	6.9

Fry colour of samples of cultivar Saturna from 6°C storage were relatively poor, and below commercially acceptable levels. Colour was lightest in samples treated with CIPC and spearmint oil. Following storage at 9°C only spearmint oil resulted in an acceptable fry colour (Hunter L >58 units).

Table 4. Fry colour (Hunter L) of cv Saturna processed as crisps following storage at 6°C and 9°C.

treatment	store temperature	
	6°C	9°C
CIPC	54.4	52.3
Carvone	51.6	52.9
Clove oil	44.9	53.6
Spearmint	54.0	59.4
Untreated	53.4	54.8

4. Discussion

Under the conditions tested, CIPC was the most effective sprout suppressant with application at 18 g/tonne resulting in effective sprout control of both cultivars, at both storage temperatures and at both storage durations. Control was generally less effective in cv Saturna and at a storage temperature of 9°C, compared with 6°.

Of the alternative sprout suppressants, caraway oil was most effective. In cv Russet Burbank, sprout control using caraway oil was comparable with that of CIPC. In the more demanding cv Saturna, sprout control was less effective than that using CIPC at 9°C.

Spearmint oil effectively controlled sprout growth of both cultivars at the lower storage temperature, but growth was poorly controlled at 9°C.

Sprout control by clove oil was generally poor. An increase in application rate and a modified application procedure did not improve efficacy of sprout control. An alternative application procedure was proposed by Pace International (Seattle, Washington, USA). It was considered that the volatility of clove oil was not sufficient, and an energy source should be used to increase headspace clove oil (eugenol) concentration. Clove oil is registered and in commercial use in the USA. Given the comments received, results for clove oil should not be considered representative of this formulation, and a modified application procedure will be employed in year 2 trials.

5. Conclusions

In this small-scale study, a single application of CIPC at store loading resulted in effective control of sprout growth during long-term storage of cvs Russet Burbank and Saturna at 6°C and 9°C. Of a range of alternative sprout suppressants caraway oil gave the most effective control. This was comparable with CIPC for Russet Burbank, but not as effective for Saturna. Sprout control by spearmint oil was effective in both cultivars at the lower storage temperature (6°C), but was relatively ineffective at 9°C, especially in samples assessed after long-term storage.

In year 2 of the work, the carvone (caraway oil) treatment will be scaled-up to a semi-commercial scale allowing full assessment of potato attributes and cost-benefit analysis.

Further analysis of processing quality, disease development and comparative cost benefit analysis of treatments will be carried out using year 1 data.

Study 438 - Alternative Sprout Suppressants

Sprouting data summary

Year 1

Variety	Treatment	Storgage temp. (C)	length mean	sites mean
R.Burbank	CIPC	6	0.7	2.2
R.Burbank	Carvone	6	0.0	0.0
R.Burbank	Clove oil	6	6.8	8.3
R.Burbank	Spearmint	6	2.0	3.6
R.Burbank	Untreated	6	10.0	10.1
Saturna	CIPC	6	1.4	2.1
Saturna	Carvone	6	0.2	0.7
Saturna	Clove oil	6	18.1	8.0
Saturna	Spearmint	6	2.9	4.2
Saturna	Untreated	6	21.0	7.4
R.Burbank	CIPC	9	1.6	13.3
R.Burbank	Carvone	9	0.3	0.7
R.Burbank	Clove oil	9	27.3	11.6
R.Burbank	Spearmint	9	38.2	11.5
R.Burbank	Untreated	9	28.9	13.4
Saturna	CIPC	9	5.5	7.2
Saturna	Carvone	9	1.0	1.8
Saturna	Clove oil	9	35.6	7.5
Saturna	Spearmint	9	31.0	6.3
Saturna	Untreated	9	40.8	8.3