SUTTON BRIDGE
Crop Storage Research

POTATO COUNCIL

Evaluation of alternative sprout suppressants

2011-12 Interim Report (Year 2)

AHDB - Potato Council
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Introduction

.Although alternative sprout suppressants are gradually becoming available, CIPC remains the main sprout suppressant used on stored potatoes. Little independent information is available on the alternatives. This project (S438) is designed to give comparative information on the efficacy of new active substances that are available or expected to become available in the near future.

In addition to the alternative active substances, an alternative method of using CIPC (*GroStop Ready*) is also included. This product is a liquid formulation which is applied directly to tubers at store loading. Although available for some years, this method of applying CIPC has never been widely adopted in the UK, unlike mainland Europe where it is frequently used.

These studies were funded by AHDB Potato Council as part of a larger programme, primarily funded by DEFRA (FO/0217: Reducing post harvest losses and wastage in UK potato storage due to sprouting). An additional study within the programme is being funded by two CIPC approval holders.

Materials and methods

Small-scale testing of a number of alternative sprout suppressants was carried out in 120 litre capacity chambers. Chambers were connected to a vacuum pump with air lines to give approximately two air changes per day (Figure 1). Clean air was sampled from an adjacent store and exhausted outside stores to ensure no cross-contamination of treatments. Separate chambers were held in stores maintained at 6°C and 9°C (±0.5C). Humidity was not controlled. Chambers were filled to contain a total weight of 42kg tubers.

Figure 1.

Sealed, 120 litre chamber in a controlled environment store.

In the second year the same treatments were used as in year 1, but with the addition of 3-decen-2-one (SmartBlock™). In addition, in year 2, untreated tubers of each cultivar were held in chambers in the stores where treatments were taking place. In year 1, untreated material was held in separate stores.

Treatments examined in year 2 are shown in Table 1.

Table 1. Sprout suppressant treatments examined in year 2.

active substance	formulation/product	supplier
CIPC	*GroStop Ready*	Certis Europe
caraway oil/D-carvone	*Talent*	Makhteshim Agan
clove oil/eugenol	*Biox-C*	Xeda
spearmint oil/L-carvone	*Biox-M*	Xeda
3-decen-2-one	*SmartBlock™*	Amvac

CIPC (*Gro-Stop Ready*) was applied, as per label, on one occasion at store loading with a nominal application rate of 18g tonne^{-1}. Application was by Mafex *Mantis* spinning disc over a conveyor belt.

Caraway oil, clove oil, spearmint oil and 3-decen-2-one were all applied into the base of chambers as cold mists using compressed air. Ventilation of chambers was suspended for 24 hours after applications.

Caraway oil was applied at the proposed weekly application rate for *Talent* for ware potatoes (initially 30 ml tonne^{-1}, reducing to 15 ml tonne^{-1}).

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

3-decen-2-one *(SmartBlock)* was applied at a rate of 115ml tonne^{-1} as required. One application was made at 6°C on 27 January 2012; four applications were made at 9°C on 9 December 2011, 27 January 2012, 16 March 2012 and 14 May 2012.

In year 1, the use of clove oil did not result in sprout control. This was discussed with approval holders in the USA (PIN/NIP and Pace). In year 2, modifications were made to improve contact between fog and sprout tissue by recirculation and by increasing volatility (through raising temperature). However, after two applications (48 ml tonne^{-1}) control was still not evident so applications and assessment of this treatment was discontinued after the first sampling occasion.

In addition to the small-scale trials, caraway oil *(Talent)* was assessed on a larger scale. The same treatment regime was used as in the small-scale trial, but applications were made to a 16 tonne block of boxes (cv Saturna) held at 9°C. Within each box, a second variety was included as a netted sub-sample (cv Russet Burbank). Boxes were stacked as a solid block of 4 columns, 4 high and were ventilated non-positively using an overhead-throw principle. Application was made using a Cyclomatic cold fogging system, located in the store headspace (Fig 2). At the time of applications, refrigeration was turned off, and store air was recirculated continuously for a period of 24 hours.

Stores were loaded during the week beginning 7 November 2011. Chambers were unloaded and assessments carried out during the weeks starting 13 February 2012

(sampling occasion 1, *c.* 3 months' storage) and 28 May 2012 (sampling occasion 2, *c.* 6 months). The second sampling in the large scale trial was carried out in the week beginning 7 May 2012.

Figure 2. Cyclomatic cold fogging system used for application of caraway oil in large scale trial.

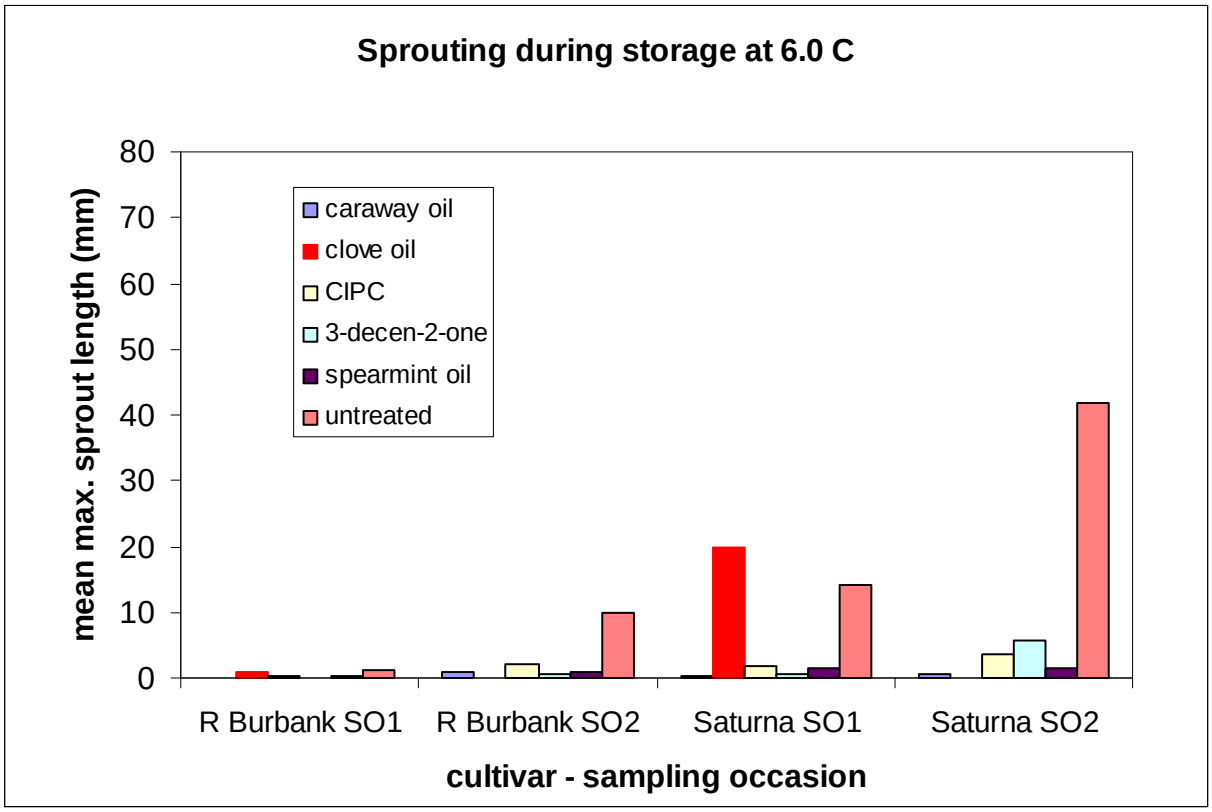
Results

Small scale trials

Results of sprouting assessments are shown in Figure 3. During storage at 6°C, all treatments resulted in very effective control of sprouting of cv Russet Burbank with mean maximum sprout length generally less than 3mm. With the exception of clove oil, where sprout length was similar to the untreated samples, sprouting in cv Saturna was also well controlled at 6°C across all treatments, with sprout length generally much less than 10mm.

Potential for sprout growth was considerably greater during storage at 9°C, with untreated samples of both cultivars having excessive sprout growth (»10mm) at the first sampling occasion. Sprout control by clove oil was, again, relatively poor with sprout length similar to that of untreated samples.

(a)



(b)

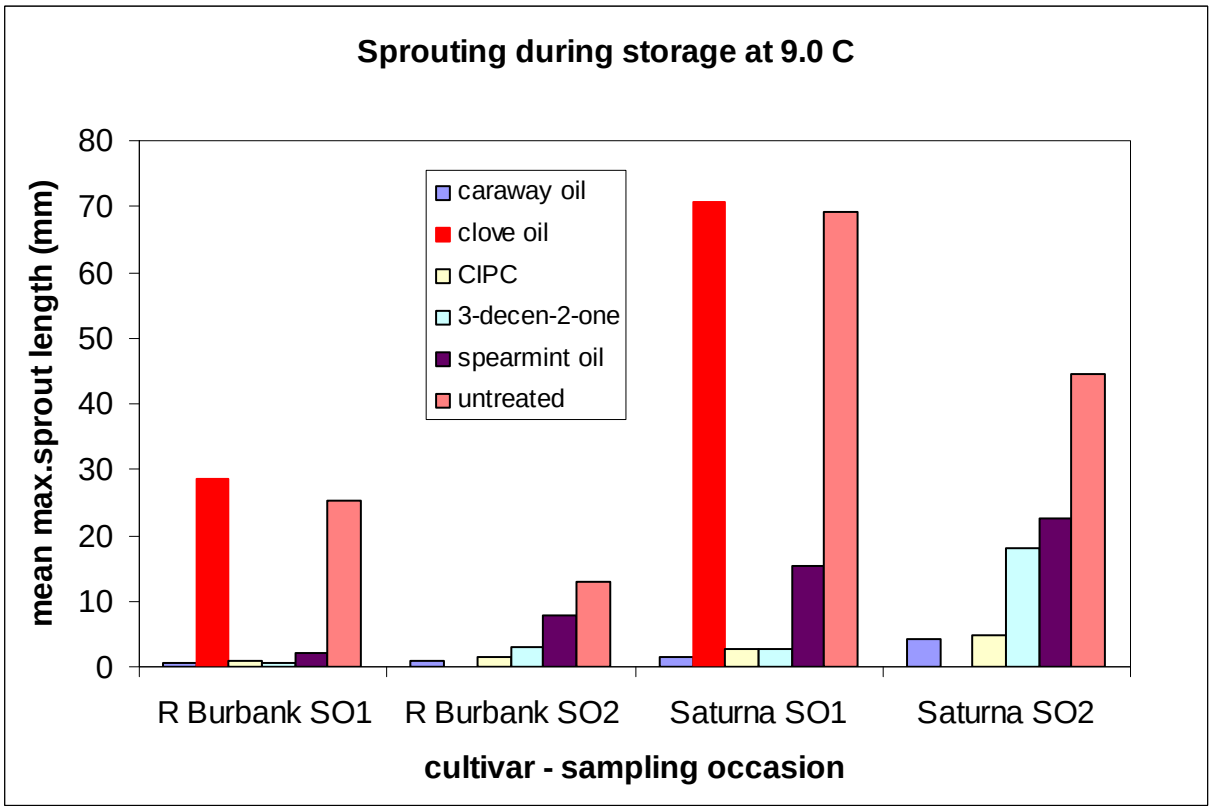


Fig. 3. Sprout growth of samples in small-scale trials stored at (a) 6°C and (b) 9°C.

With the exception of clove oil, there was little difference in sprout control efficacy of cv Russet Burbank from the different treatments during storage at 9°C. With cv Saturna, sprouting was most effectively controlled using CIPC *(GroStop Ready)* and caraway oil *(Talent)* with sprout length remaining less than 10mm.

Fry colour of Russet Burbank stored at 6°C was unaffected by the different sprout suppressants. At sampling occasion 1, mean fry colour was in the range 3.8 - 4.1 (USDA 1)[1] and, at sampling occasion 2, slightly darker being in the range 4.8 - 5.5 (USDA 2). At unloading from 9°C storage, the mean fry colour range was 3.5 - 4.1 (USDA 1) for sprout suppressant treatments and 5.1 (USDA 2) for untreated samples.

Compared with Russet Burbank, fry colour of cv Saturna was relatively poor. Acceptable processing quality in this cultivar only occurred at sampling occasion 1 using caraway oil, 3-decen-2-one, spearmint oil and in the untreated control.

Large scale trials

The use of caraway oil was less effective in the large scale trial (Table 2). With cv. Saturna, sprout length was greater than 10mm at the first sampling occasion and unacceptably excessive at sampling occasion 2. With longer dormant cultivar Russet Burbank sprout length was acceptable at the first sampling occasion (<3mm), but also excessive at store unloading with a mean longest sprout length greater than 30mm. With both cultivars there was only evidence of sprout control in top boxes close to where the applicator was located. In these boxes average sprout length was c. 5mm in cv Russet Burbank and c. 45mm in cv Saturna at store unloading.

Table 2. Mean maximum sprout length (mm) of samples in the large scale trial

cultivar	sampling occasion		sampling occasion	
	1	SD	2	SD
Russet Burbank	**1.4**	0.43	**32.8**	21.04
Saturna	**11.4**	5.93	**77.8**	33.80

[1] French fry colour values are based on a linearised USDA score as follows:

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

Processing quality of both cultivars was good at sampling occasion 1 with a mean fry colour score of 3 for Russet Burbank (equivalent to USDA 0). Fry defects were below 10% with a base colour of over 58 (Hunter L value) for cv Saturna.

At sampling occasion 2, although sprout control was not effective, processing quality of Russet Burbank remained commercially acceptable. At this time, fry defects and fry colour were not acceptable for cv Saturna.

Discussion

Comparative data from two seasons of small-scale trials indicate sprout control to have been most effective from use of CIPC, applied at store loading. Of the alternatives, weekly applications of caraway oil gave relatively effective sprout control. In year 2 sprout control with caraway oil was very effective, and similar to CIPC. This was the case both under straightforward (cool storage, long-dormant crop [cv. Russet Burbank at 6°C]) and more demanding sprout control conditions (warm, short-dormant [cv. Saturna at 9°C]).

However, a similar treatment regime resulted in poor sprout control in the large-scale trial with evidence of efficacy only apparent in top boxes, close to where the applicator was located. Poor efficacy elsewhere in the store indicates limited transport of the sprout suppressant into the block of boxes. With the overhead-throw ventilation principle, air (and any treatments applied using air) is not moved through crop, but through the pallet apertures of boxes, with the delivery to crop being effected by convection currents. This limits the effectiveness of such stores for drying and chemical applications (Potato Council Store Managers' Guide, 2008). Results from this first year of the large scale trial suggest that simply using a sprout suppressant with high volatility will not easily overcome limitations of the overhead-throw store design. The likely availability of caraway oil (*Talent*) for commercial use on ware potatoes in the United Kingdom is currently unclear.

3-decen-2-one was used for the first time in the 2011-12 season in the small-scale trial. With this compound, differences in the number of applications (triggered by the onset of sprouting) as a result of storage temperature was notable, with a single

application required at 6°C and four applications at 9°C. The compound is currently undergoing registration trials in Europe.

Sprout control from spearmint oil has been effective over shorter term storage (to SO1) or at the lower storage temperature, in both seasons. However, it has failed to prevent sprout development under more demanding conditions. In the final year, spearmint oil will be used in the large scale trial, but using positive ventilation which, it is anticipated, may improve efficacy of sprout control. Spearmint oil is currently available commercially on an experimental approval (*Biox-M*).

Conclusions

In small-scale trials of alternatives to CIPC, caraway oil has consistently given best control of sprouting. However, its efficacy on scaling-up to 16 tonnes of crop held in an experimental ‘overhead-throw’ box store was poor and demonstrates the importance of effective delivery mechanisms in achieving successful control in commercial stores.

Further work will be carried out in year 3 to assess relative performance of alternatives and to assess the performance of spearmint oil on a semi-commercial scale.

Study 438 - Alternative Sprout Suppressants

Sprouting data summary

Year 2

Temp	Treatment \ Variety	Longest sprout length				Standard deviation				Minimum length				Maximum length			
		SO1	SO2	SO1	SO2	SO1	SO2	SO1	SO2	SO1	SO2	SO1	SO2	SO1	SO2	SO1	SO2
		Russet Burbank	Russet Burbank	Saturna	Saturna	Russet Burbank	Russet Burbank	Saturna	Saturna	Russet Burbank	Russet Burbank	Saturna	Saturna	Russet Burbank	Russet Burbank	Saturna	Saturna
6.0 C	Carvone	0.00	0.93	0.35	0.53	0.00	0.27	0.48	0.51	0	0	0	0	0	1	1	1
	Clove oil	0.85		19.80		1.23		11.40		0	0	1	0	5	0	40	0
	Grostop Ready	0.28	2.15	1.75	3.70	0.55	1.83	1.15	4.81	0	0	0	1	2	8	5	25
	Smartblock 115ppm	0.00	0.58	0.68	5.78	0.00	0.50	1.07	4.16	0	0	0	1	0	1	5	15
	Spearmint Oil	0.20	0.98	1.53	1.43	0.46	0.16	0.78	0.65	0	0	0	1	2	1	4	4
	Untreated	1.20	10.00	14.23	41.93	2.41	6.36	9.54	9.86	0	2	2	24	14	24	37	69
9.0 C	Carvone	0.50	0.95	1.38	4.10	0.55	0.22	0.98	5.44	0	0	1	0	2	1	6	22
	Clove oil	28.68		70.70		24.40		27.96		1	0	2	0	79	0	125	0
	Grostop Ready	0.90	1.61	2.77	4.83	0.71	2.27	1.65	6.42	0	1	1	1	3	15	7	42
	Smartblock 115ppm	0.58	2.93	2.60	18.18	1.24	4.46	3.54	10.48	0	0	0	0	6	21	13	45
	Spearmint Oil	2.05	7.85	15.23	22.54	1.06	6.76	6.01	7.36	1	1	2	3	5	29	26	36
	Untreated	25.30	12.95	69.30	44.43	24.84	13.27	29.43	17.46	0	0	28	13	95	50	147	86