



Final Report 2020-21

Processing trial to assess potato varieties' suitability for ethylene and low temperature storage

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Sutton Bridge Crop Storage Research

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1. Summary

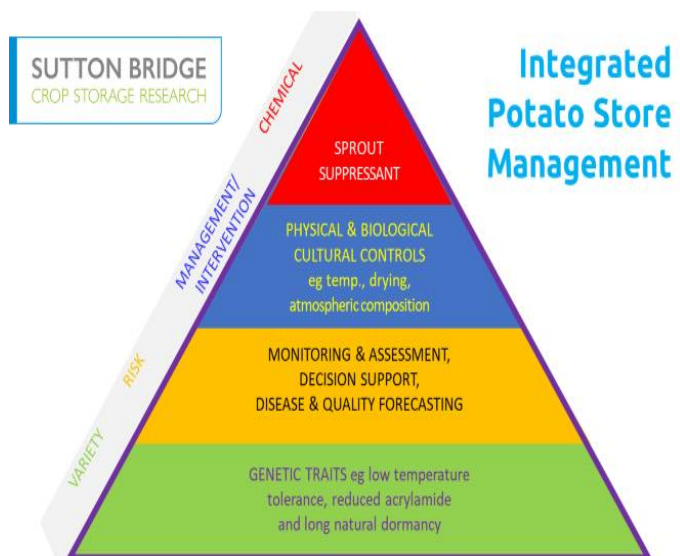
It is not possible to simply ‘plug and play’ a new product into the gap left by CIPC, the sprout suppressant that has served the potato industry for the last 70 years, which lost its approval for use in 2020.

None of the new actives (that the industry in GB currently has access to) works in the same way; the products need a wider appreciation of their limitations and appropriate adjustment of the environment within the store to get the best possible results. Many of the new chemistry options are very volatile and require specific management to get the best performance from each product. Some, like ethylene, are continuously applied so measures are needed to avoid excess loss through the ventilation system, particularly in ambient stores.

The bottom line is that there is now a much greater need for integrated management of the potato store (see graphic) and this trial is being run to help gather data to support the decision making processes that will form part of that management.

Ethylene, as a plant hormone, has a strong interaction with variety but this is an area of knowledge which is poorly documented across many varieties at present and one driver for this trial to try to identify those which perform best with the treatment.

Cost has a big part to play in the new potato storage strategies and, with some sprout suppressant products costing as much as four times the price of a regular dose of CIPC, there is a need to identify processing varieties with better cold temperature tolerance as these will offer storage options needing fewer chemical inputs.



The first year of the trial (2019/20) was set up to begin to capture information on ethylene performance and low temperature storage (6°C) tolerance in a single piece of work, using crops held at 8°C treated with a single sprout suppressant (DMN) as a control. This was reported separately. Indicative interim data was obtained from the work, but variability between lots supplied from industry was high and there were inconsistencies such as maleic hydrazide treatment to take into account.

In Year 2 a similar approach was taken but, to reduce variability, results are presented in this report as two trials, one assessing performance during ethylene treatment, the other assessing response to low temperature storage, albeit sharing a single control.

This work, in the two years the trial has run, has highlighted in broad terms that it is possible to successfully store crops for processing at i) lower temperatures (6°C) and ii) under ethylene treatment, as an alternative sprout suppressant. The key to either of these approaches as part of

a strategic change to store management for the sector is to pick the correct varieties which not only must satisfy the needs of the end market but also provide a consistent response under the alternative management strategy selected. This screening trial highlighted some potential candidates for such strategies, but did not achieve consistent responses from a single variety grown at different sites or under a range of climatic conditions. Further, detailed work will be needed to achieve this on the most responsive cultivars.

2. Introduction

Sutton Bridge Crop Storage Research was commissioned by AHDB to investigate the reaction of numerous stocks and varieties of processing potato to storage under lower temperatures or under ethylene to effect satisfactory sprout control. Following the withdrawal of approval for Chlorpropham (CIPC) to be used as a sprout suppressant in early 2020, alternative measures for the control of sprouting have been required from harvest 2020 onwards.

Originally, in summer 2019, processors, growers and plant breeders were invited to submit stocks for a storage trial under three regimes. Ethylene, low temperature and a typical standard processing temperature (control). The scale of the study was kept small in order to be able to evaluate many varieties replicated at intake and at 2 sampling occasions from storage. The design was similar for the second year's work in 2020/21, but the two experiments were separated.

Experiment 1 looked at the impact of cooler storage. The test treatment was storage at 6°C with a control held at 8°C. For both treatments, 1-4 dimethylnaphthalene (DMN) was used as the sprout suppressant. Although not approved for use in the UK at the time of writing, its registration is pending and it may become available during the 2021/22 season, so information on variety response could prove useful.

In experiment 2, where both stores were held at 8°C, sprout control by ethylene was evaluated as it is already an approved product and a cost-effective option to replace CIPC. For the control, 1-4 dimethylnaphthalene (DMN) was again used.

All stocks were evaluated for weight loss, sprouting (length of longest sprout) and processing quality (crisp or French fry, as advised by the supplier of the crop), on two sampling occasions, planned after approximately 15 and 30 weeks' storage.

3. Materials and methods

A total of 61 individual lots of potatoes were gathered from various suppliers and loaded into store for long term storage under either, ethylene, low temperature storage with DMN or normal temperature storage under DMN. Storage regimes are listed in tables 1 & 2:

Table 1: Experiment 1 storage regimes

Treatment	Storage temperature	Sprout suppression product
Low temp (DMN 6)	6.0 C	DormFresh 1-4 SIGHT®: 1-4 dimethylnapthalene
Control (DMN 8)	8.0 C	DormFresh 1-4 SIGHT®: 1-4 dimethylnapthalene

Table 2: Experiment 2 storage regimes

Treatment	Storage Temperature	Sprout Suppression
DMN 8	8.0 C	DormFresh 1-4 SIGHT®: 1-4 dimethylnapthalene
Ethylene	8.0 C	RESTRAIN: ethylene

Stores (3x 12 tonne units) were loaded between 2nd October and 26th October 2020. Loading dates are given alongside each stock listed in Table 2. These were the same for each experiment.

Table 3: Stocks held in storage 2020/21

Stock	Variety	Supplier	On site	Fry	Intake Fry
1	Lady Claire	KP Snacks	15/10/2020	Crisp	21/10/2020
2	Lady Alicia	KP Snacks	13/10/2020	Crisp	21/10/2020
3	Opal	KP Snacks	13/10/2020	Crisp	21/10/2020
4	SHC1010	KP Snacks	15/10/2020	Crisp	21/10/2020
5	Triple 7	KP Snacks	13/10/2020	Crisp	21/10/2020
11	Lady Amarilla	Meijer		Crisp	21/10/2020
12	Lady Claire	Meijer		Crisp	21/10/2020
14	Lady Alicia	Meijer		Crisp	21/10/2020
17	Olympus	Cygnnet	21/10/2020	Crisp	21/10/2020
21	SHC1010	Stet Potato		Crisp	21/10/2020
28	Lady Claire	Mercian	09/10/2020	Crisp	21/10/2020
29	Brooke	Mercian	09/10/2020	Crisp	21/10/2020
30	Pirol	Mercian	09/10/2020	Crisp	21/10/2020
31	Shelford	Mercian	09/10/2020	Crisp	21/10/2020
32	Taurus	Greenvale		Crisp	21/10/2020
46	Heraclea	SA Consulting	16/10/2020	Crisp	21/10/2020
50	VR808 (1)	Pepsico		Crisp	21/10/2020
51	VR808 (2)	Pepsico		Crisp	21/10/2020

<i>Stock</i>	<i>Variety</i>	<i>Supplier</i>	<i>On site</i>	<i>Fry</i>	<i>Intake Fry</i>
52	VR808 (3)	Pepsico		Crisp	21/10/2020
53	VR808 (4)	Pepsico		Crisp	21/10/2020
54	SHC909 (1)	Pepsico		Crisp	21/10/2020
55	SHC909 (2)	Pepsico		Crisp	21/10/2020
59	Odysseus	Solana	16/10/2020	Crisp	21/10/2020
60	Papageno	Solana	16/10/2020	Crisp	21/10/2020
61	Taurus	Heygate		Crisp	21/10/2020
6	Agria	Agrico	07/10/2020	FF	02/11/2020
7	Babylon	Agrico	07/10/2020	FF	02/11/2020
8	Lugano	Agrico	07/10/2020	FF	02/11/2020
9	Markies	Agrico	07/10/2020	FF	03/11/2020
10	Performer	Agrico	07/10/2020	FF	02/11/2020
13	Lady Anna	Meijer	15/10/2020	FF	02/11/2020
15	Kingsman	Cygnnet	21/10/2020	FF	03/11/2020
16	Elland	Cygnnet	21/10/2020	FF	03/11/2020
18	Innovator	McCain		FF	02/11/2020
19	Royal	McCain	15/10/2020	FF	03/11/2020
20	Russet Burbank	McCain		FF	02/11/2020
22	Markies	LWM	19/10/2020	FF	03/11/2020
23	Maris Piper	LWM	19/10/2020	FF	02/11/2020
24	Challenger	LWM	19/10/2020	FF	02/11/2020
25	Ivory Russet	LWM	19/10/2020	FF	03/11/2020
26	Fontaine	LWM	19/10/2020	FF	02/11/2020
27	Innovator	LWM	19/10/2020	FF	03/11/2020
33	Maris Piper	Greenvale		FF	03/11/2020
34	Asterix	Greenvale	02/10/2020	FF	03/11/2020
35	Desiree	Greenvale	02/10/2020	FF	02/11/2020
36	Innovator	Greenvale	02/10/2020	FF	02/11/2020
37	Fontaine	Greenvale	02/10/2020	FF	02/11/2020
38	Daisy	Greenvale	02/10/2020	FF	02/11/2020
39	Eurostar	Greenvale		FF	03/11/2020
40	Sagitta	Greenvale		FF	03/11/2020
41	Marvel	Caledonia/ Isle of Ely	06/10/2020	FF	21/10/2020
42	Amanda	Nottage/Bateman	13/10/2020	FF	02/11/2020
43	Rock	Nottage/Bateman	07/10/2020	FF	03/11/2020
44	Lady Jane	Nottage/Bateman	13/10/2020	FF	02/11/2020
45	Valencia	SA Consulting	07/10/2020	FF	02/11/2020
47	Agria	Fen Edge		FF	03/11/2020
48	Rooster MH+	Bartlett	20/10/2020	FF	03/11/2020
49	Rooster MH Free	Bartlett	20/10/2020	FF	03/11/2020
56	Amanda	Solana	16/10/2020	FF	03/11/2020
57	Edison	Solana	16/10/2020	FF	03/11/2020
58	Forza	Solana	16/10/2020	FF	03/11/2020

Stocks supplied were divided to provide, for each experiment, 3 replicate samples for each treatment across two sampling occasions plus a set for intake assessment. In a change from the initial year's work, samples were stored in nylon nets within bulked up one-tonne boxes. Boxes were stacked in a single column, three boxes deep and four high within each store.

Store temperature control was initiated on 26th October 2020 at 14.5 °C and set for immediate temperature pull down at 0.5°C per day. Holding conditions of 8.0°C storage were attained on 9th November 2020 and the 6.0°C storage temperature was reached on 16th November 2020.

Treatment equipment

Treatments were applied at the rates and dates shown in Table 4. Post-harvest applications of 1,4 dimethylnaphthalene (DMN) [1-4 SIGHT® DormFresh Ltd] were made using an electric CEDAX Electrofog machine [Xeda International SA] (Fig 1) with fans operating at low speed pressurising the hot chemical fog as it was applied to move it through the crop via the ventilation plenum.

Ethylene [as RESTRAIN®, Restrain Co Ltd] was added as a continuous treatment, aiming to maintain an atmospheric concentration of 10 ppm ethylene within the store at all times, after a pre-programmed start-up 'ramp'. This ramping process introduces ethylene at a very low dose and gradually increases this over a period of 21 days until the 10 ppm level is reached.

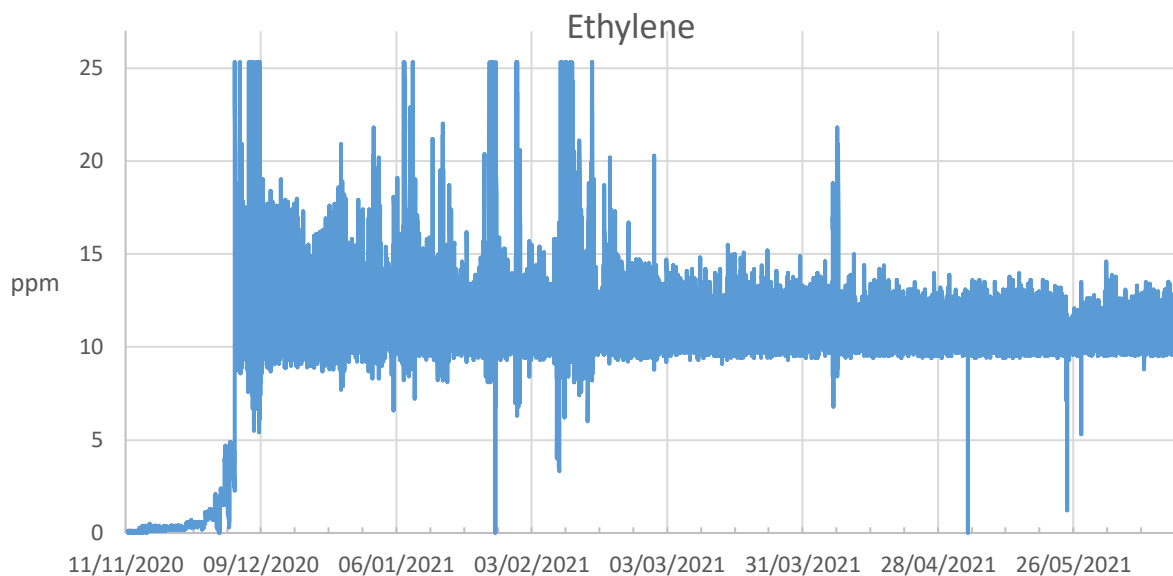
Table 4. Sprout suppressant application details

Store	Product	Application			
		1 (20ml/t)	2 (15ml/t)	3 (15ml/t)	4 (15ml/t)
DMN8 (control)	1,4 SIGHT DMN	11/11/20	11/01/21	17/02/21	07/04/21
DMN 6	1,4 SIGHT DMN	11/11/20	11/01/21	17/02/21	07/04/21
Ethylene	Restrain	Ramped start then 10ppm continuously from 11/11/20			



Figure 1. CEDAX Electrofog EWH-3000 used for application of DMN.

Chart showing Ethylene levels in the Restrain store



4. Results

Sprouting at intake was minimal with only a few stocks showing any signs of early sprout development; these are listed below in Table 5.

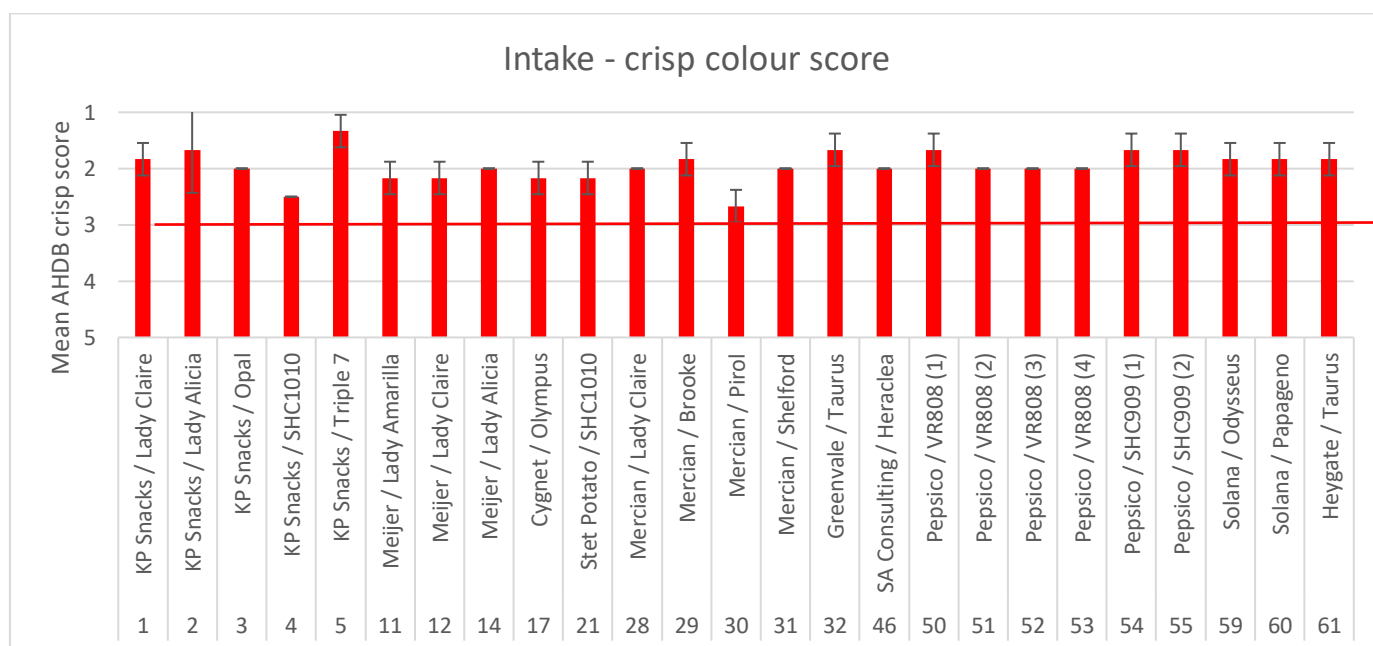
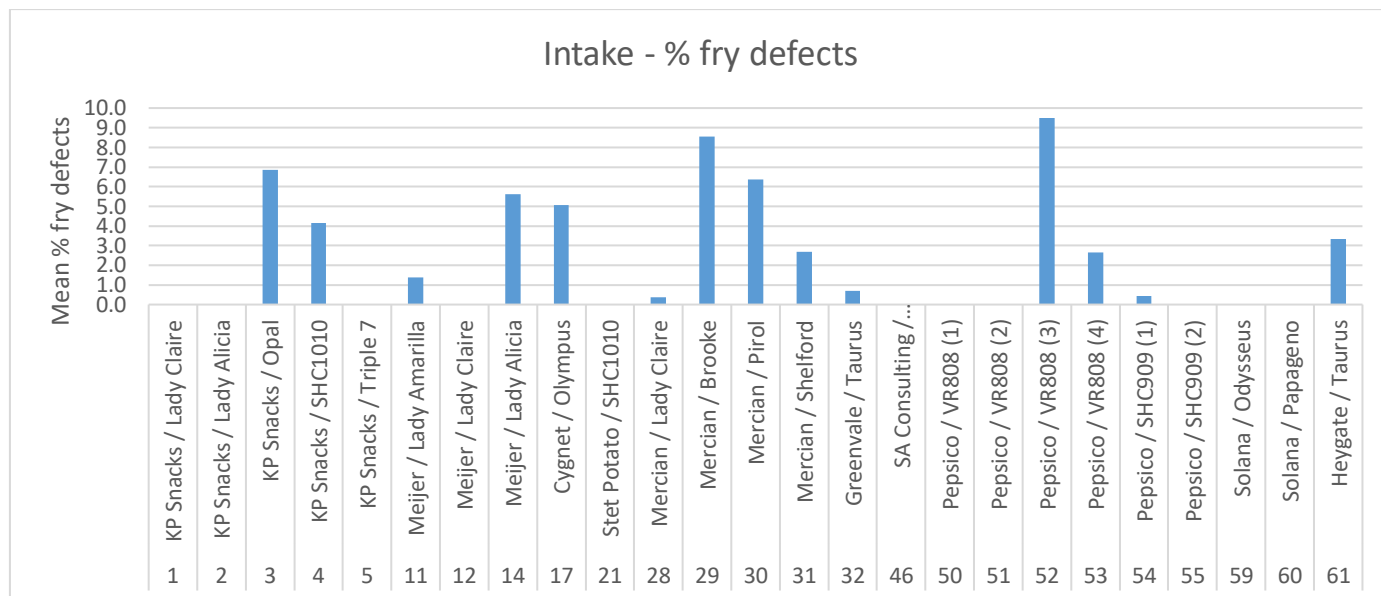
Table 5: Stocks exhibiting sprouting at intake

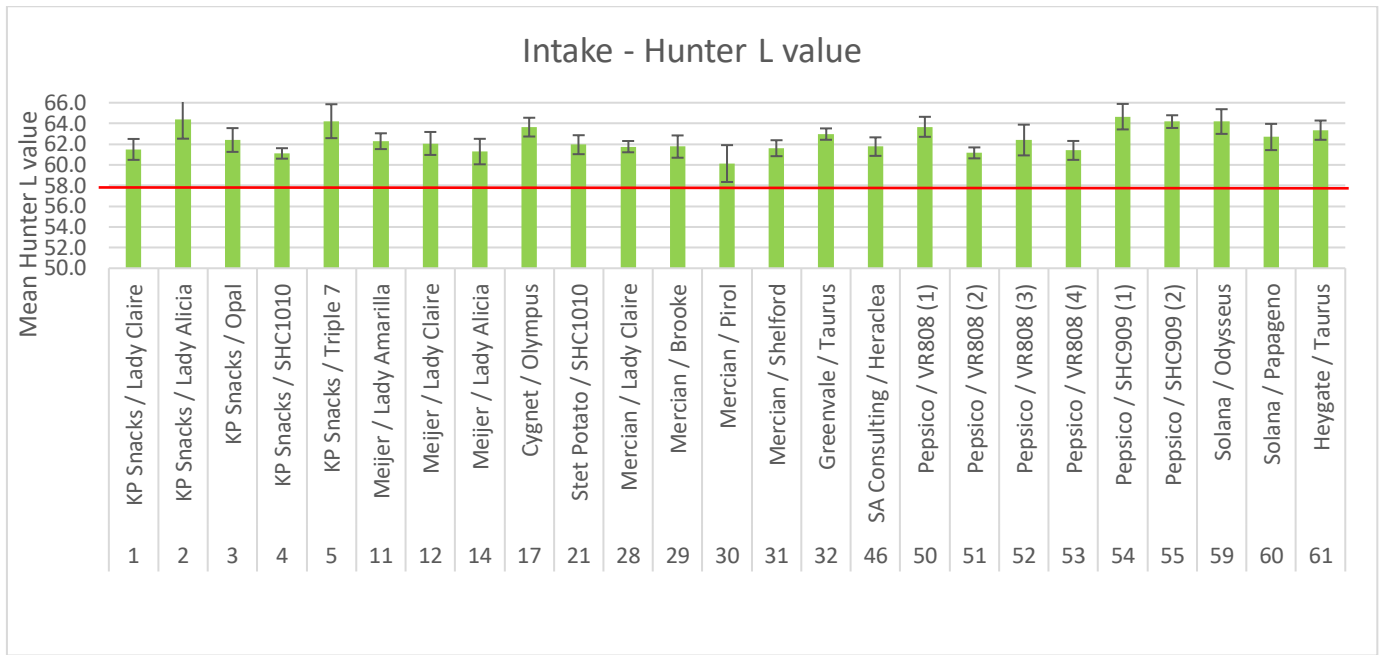
Stock	Variety	Mean longest sprout (mm)	SD
1	Lady Claire	0.01	0.12
5	Triple 7	0.11	0.48
11	Lady Amarilla	0.66	2.37
12	Lady Claire*	0.41	1.15
14	Lady Alicia*	0.11	0.35
23	Maris Piper*	0.07	0.30
28	Lady Claire*	0.17	0.76
29	Brooke*	0.01	0.12
33	Maris Piper	0.04	0.20
34	Asterix	0.92	2.04
36	Innovator	0.01	0.12
38	Daisy	0.40	0.55
44	Lady Jane*	0.01	0.12
52	VR808(3)	0.01	0.12
58	Forza	0.01	0.12

*MH treated.

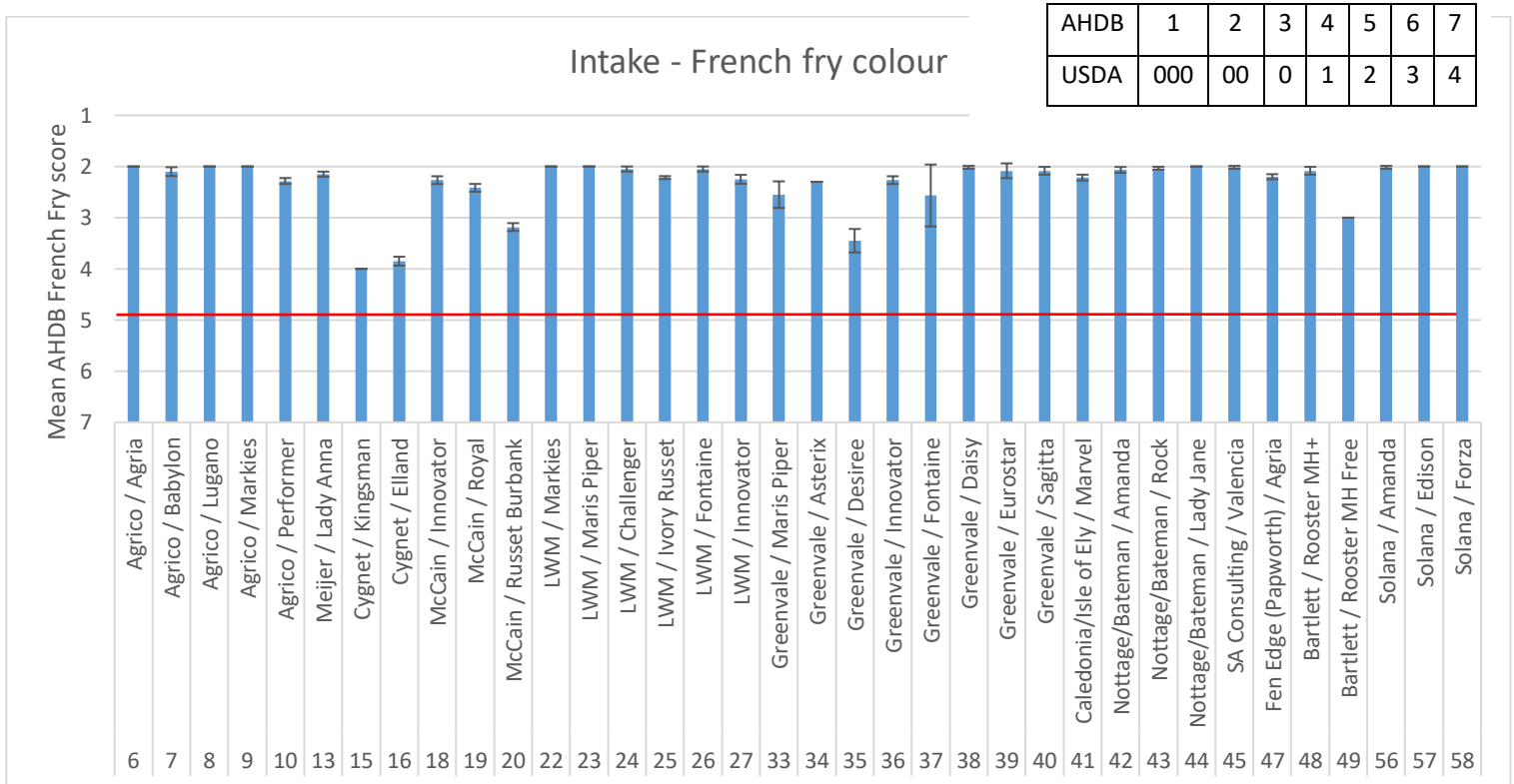
At intake, all crops were assessed for fry colour as crisps or French fry according to the nominated end use (Table 3).

Crisps



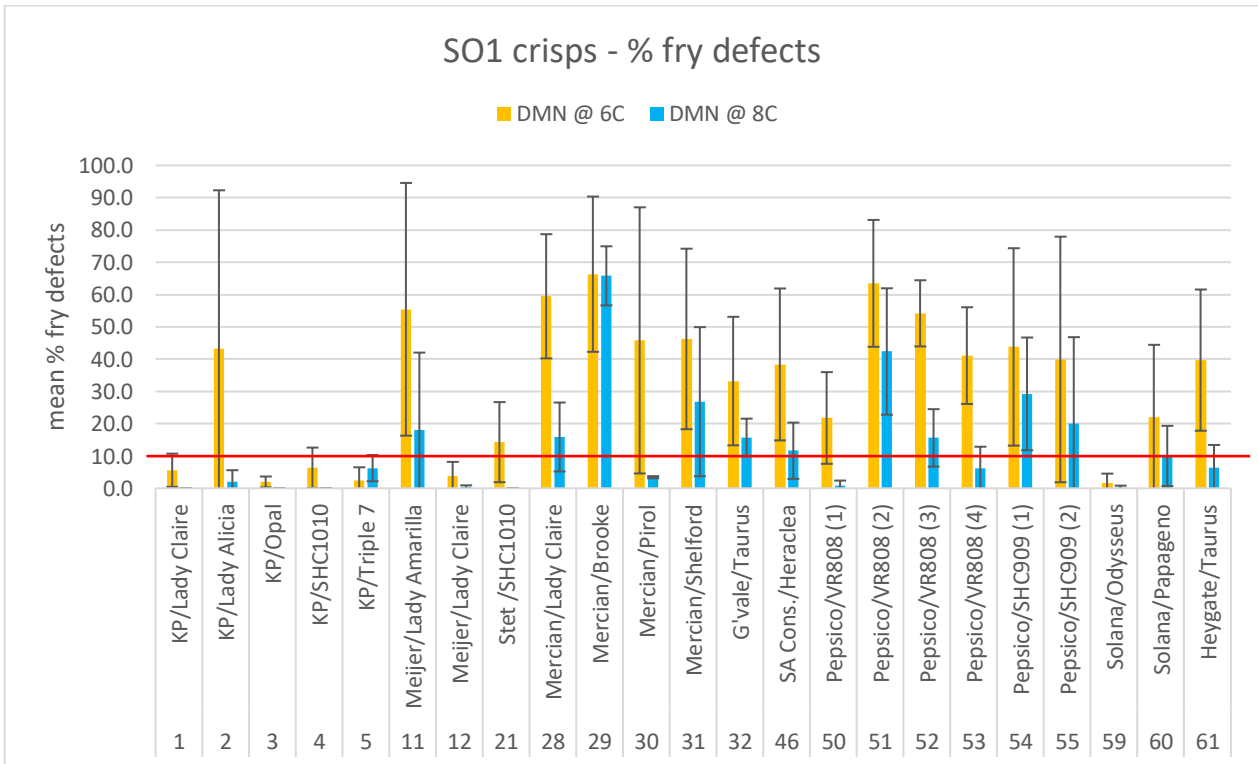
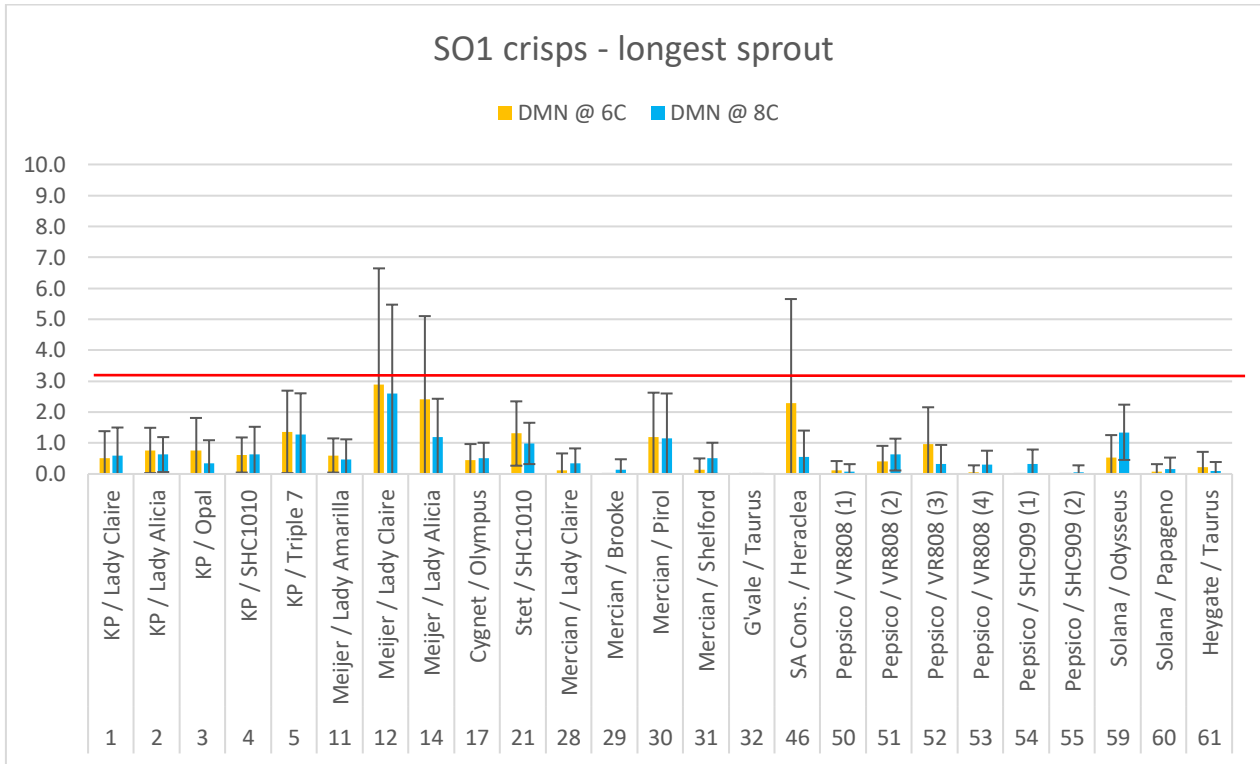


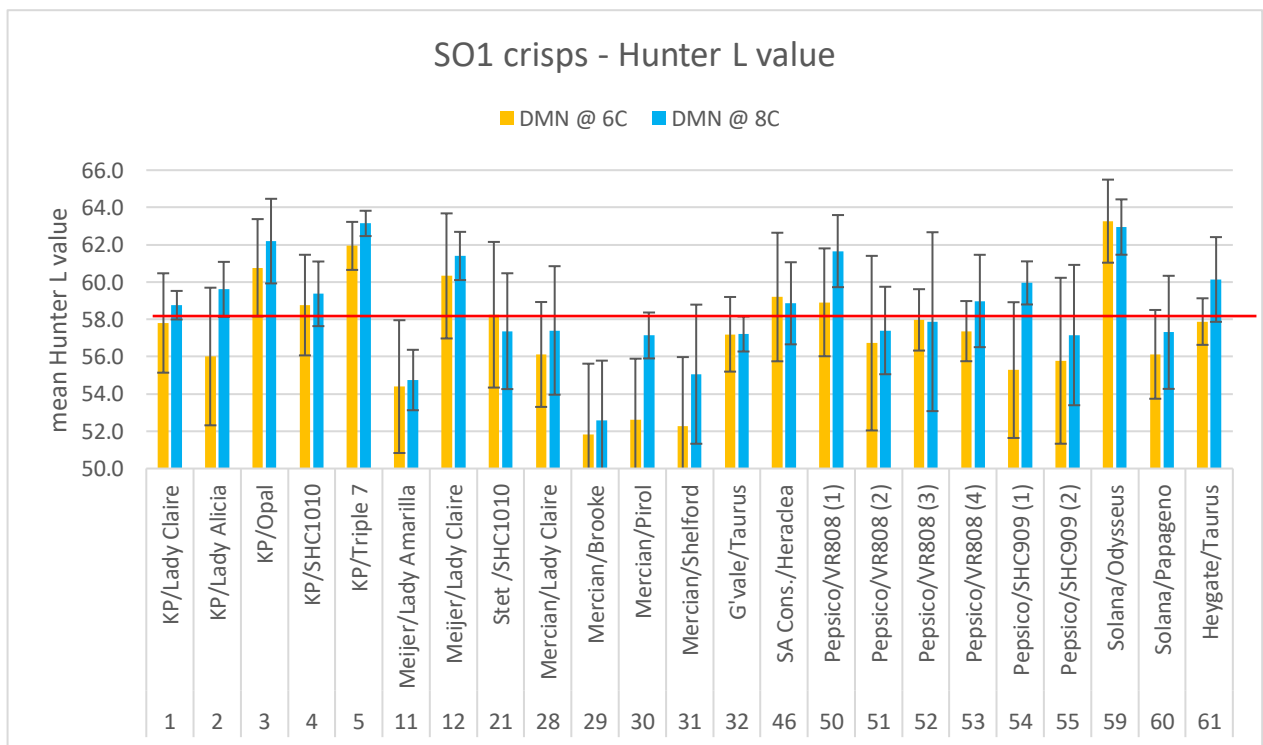
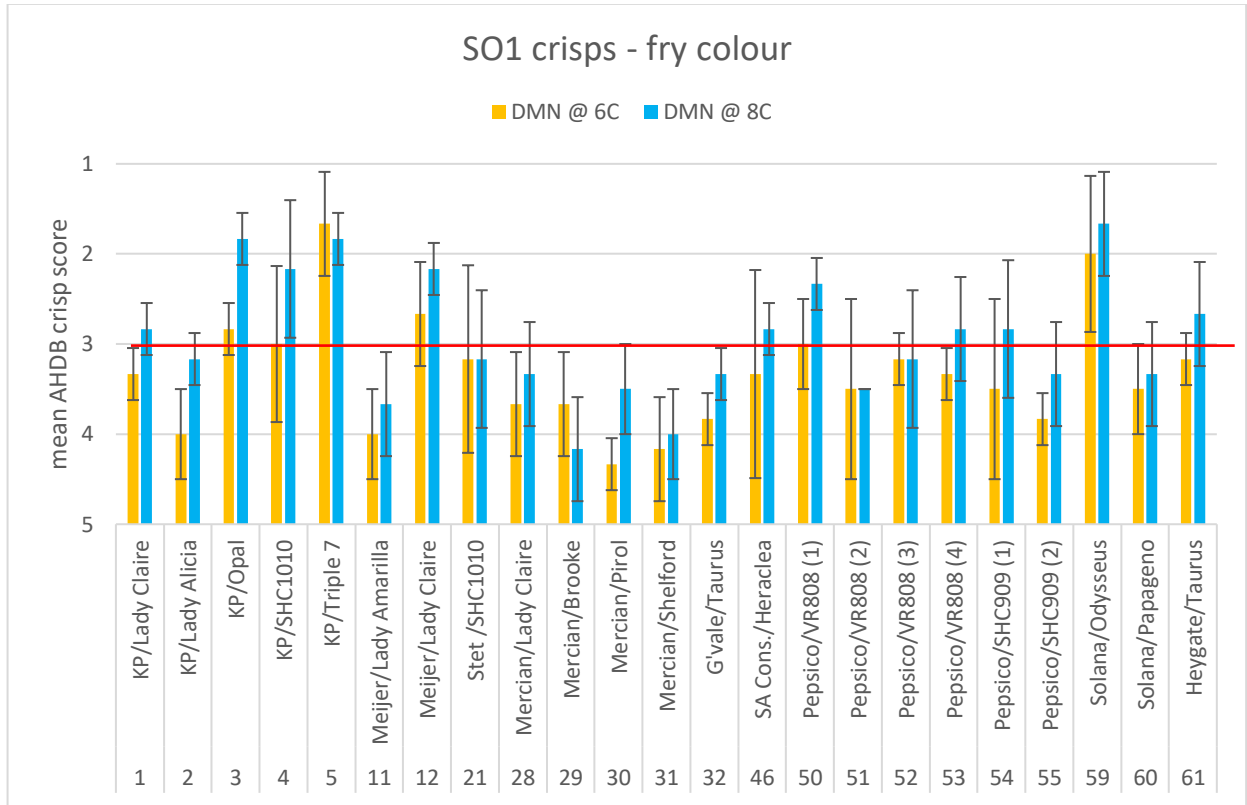
French fry



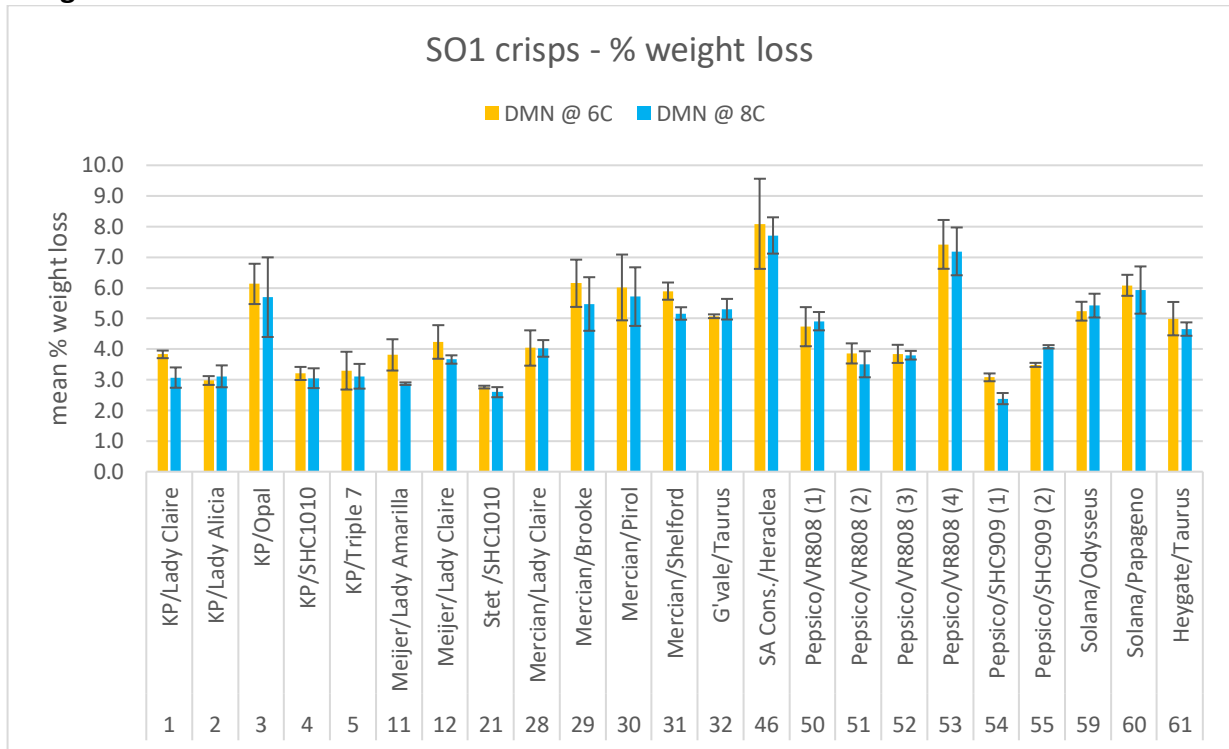
SAMPLING OCCASION 1 (Experiment 1): from 9th February 2021

Crisps



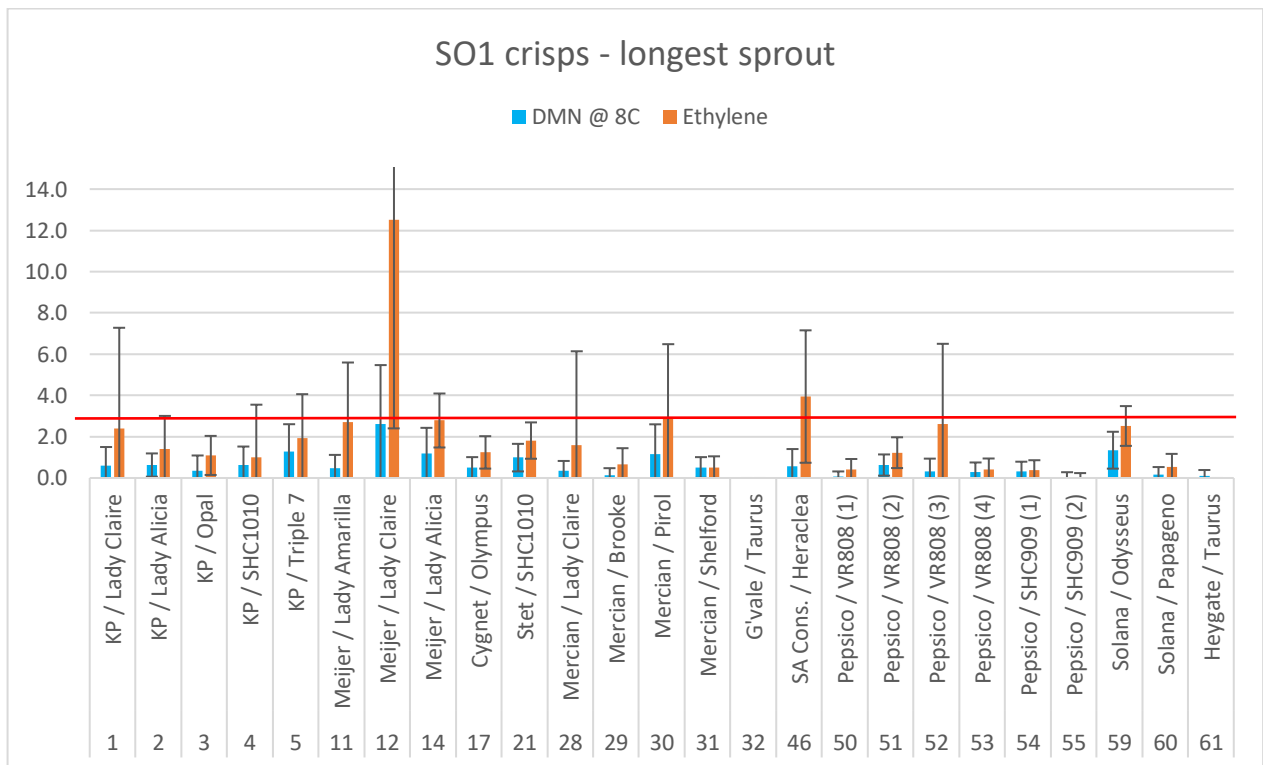


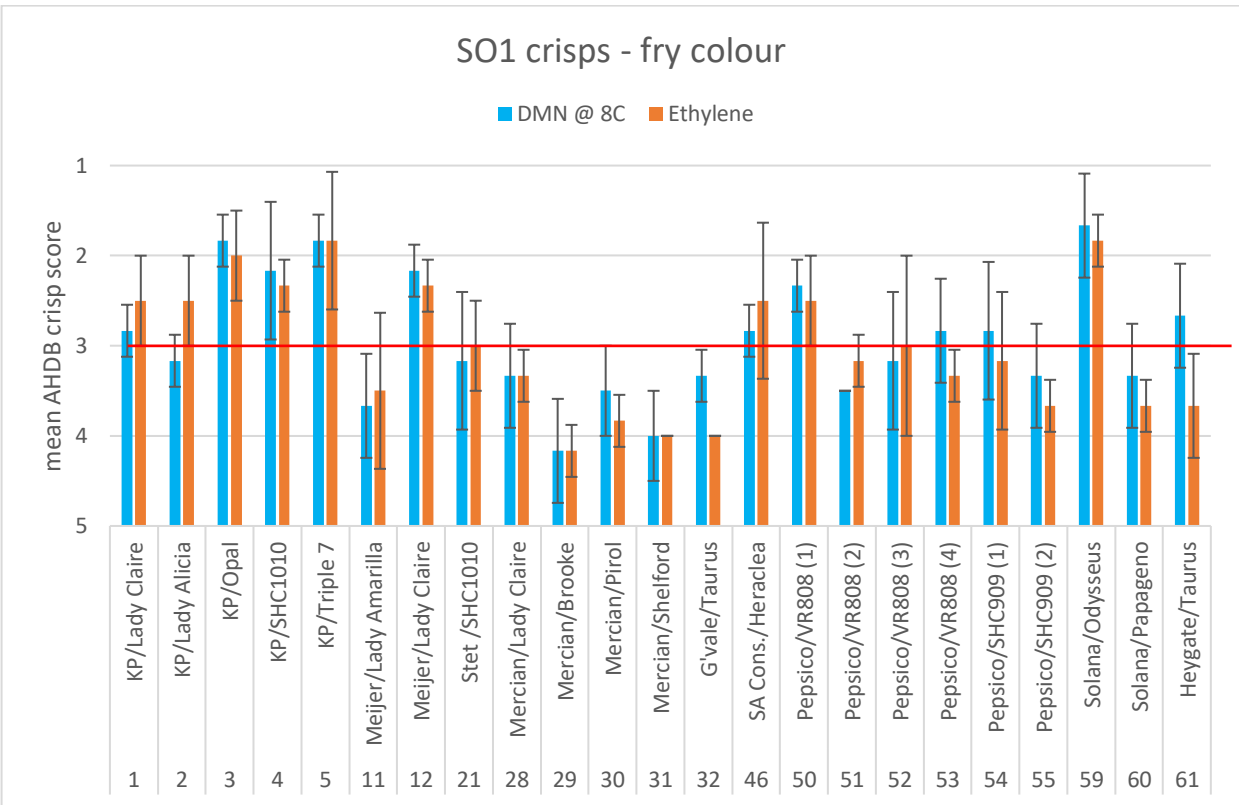
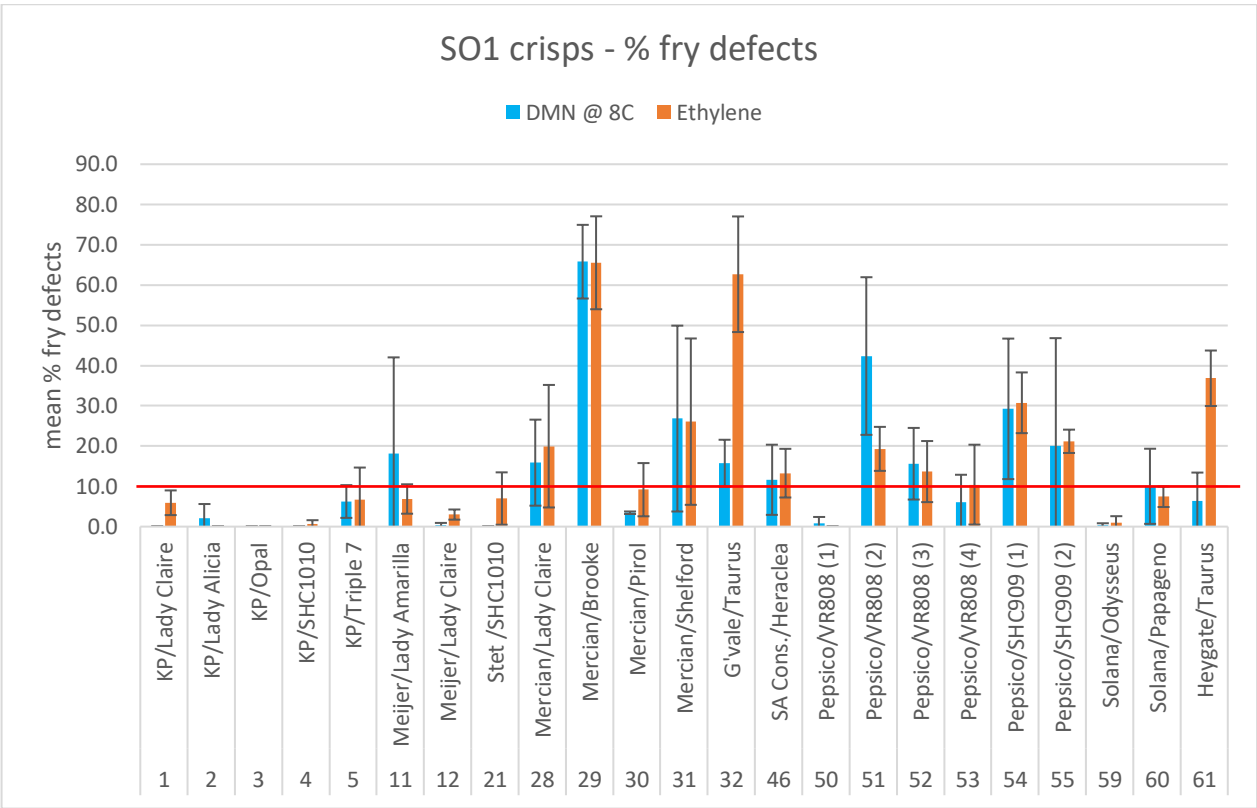
Weight loss

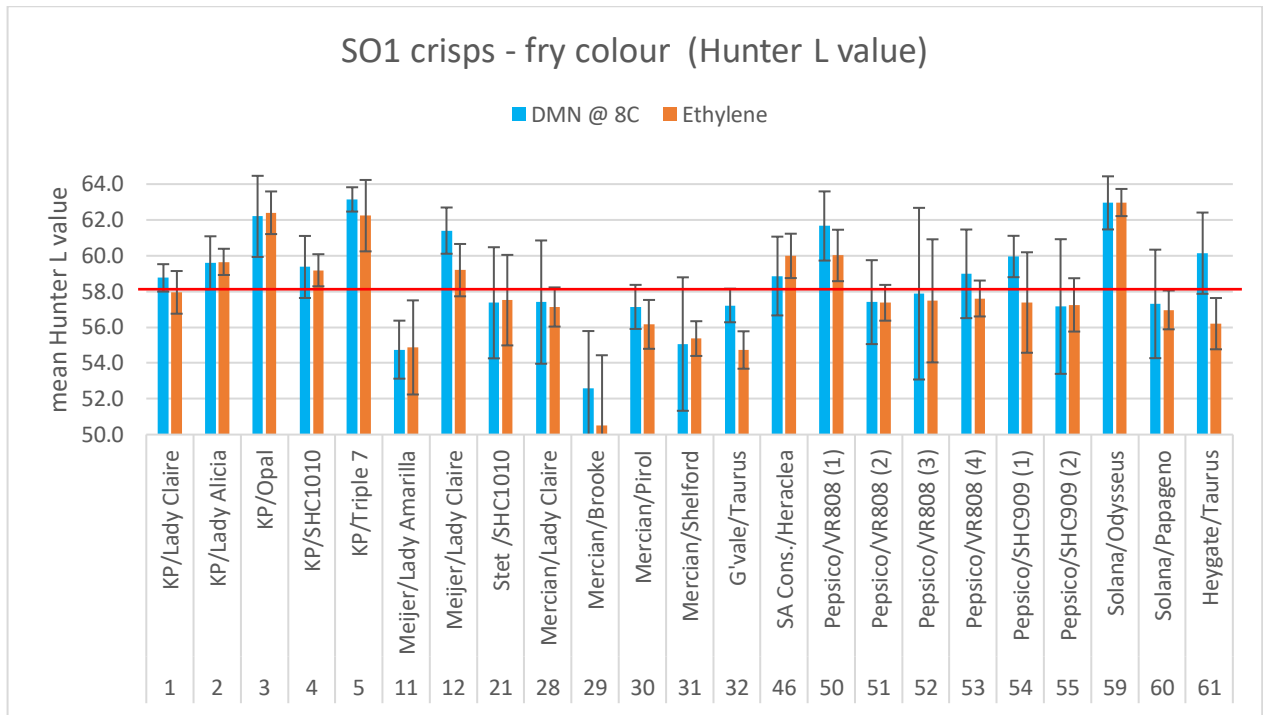


SAMPLING OCCASION 1 (Experiment 2): from 9th February 2021

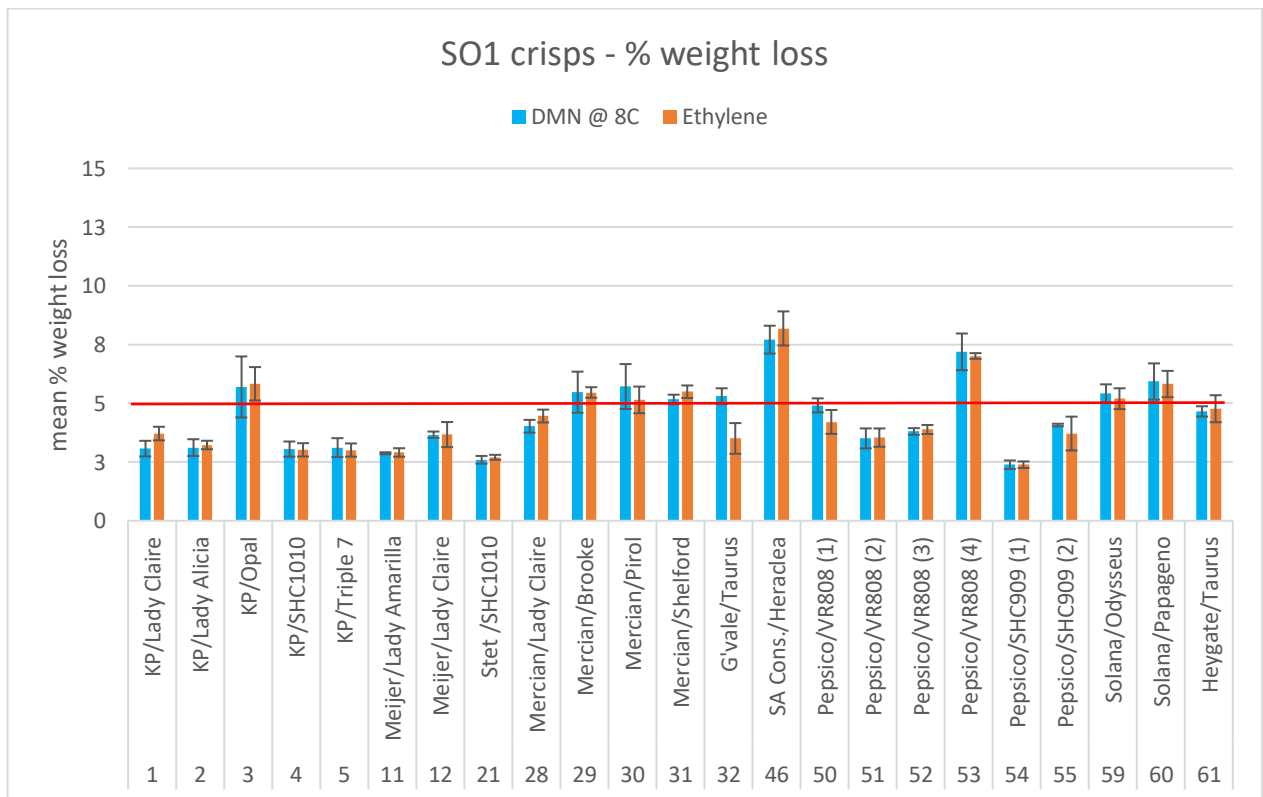
Crisps





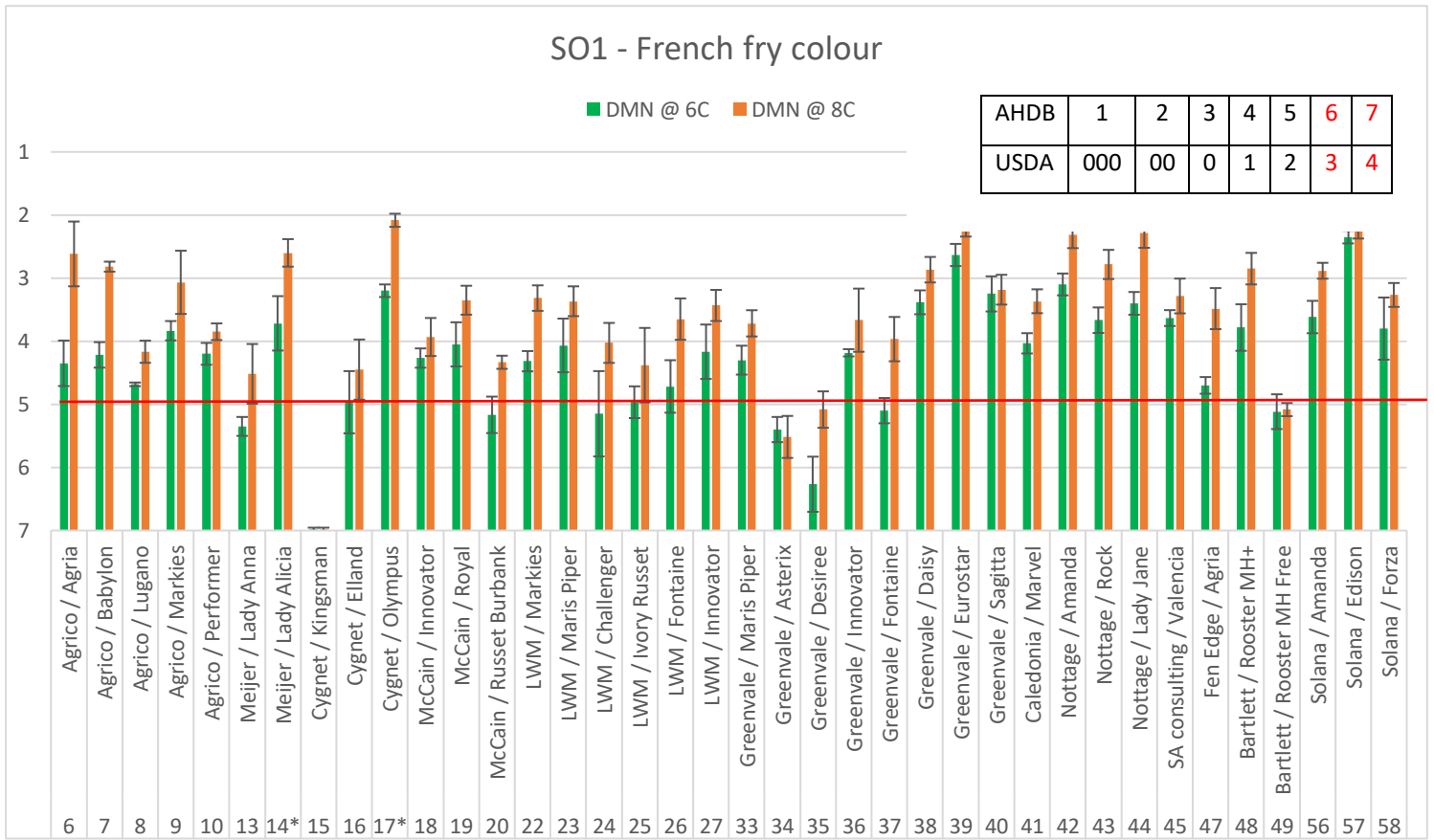
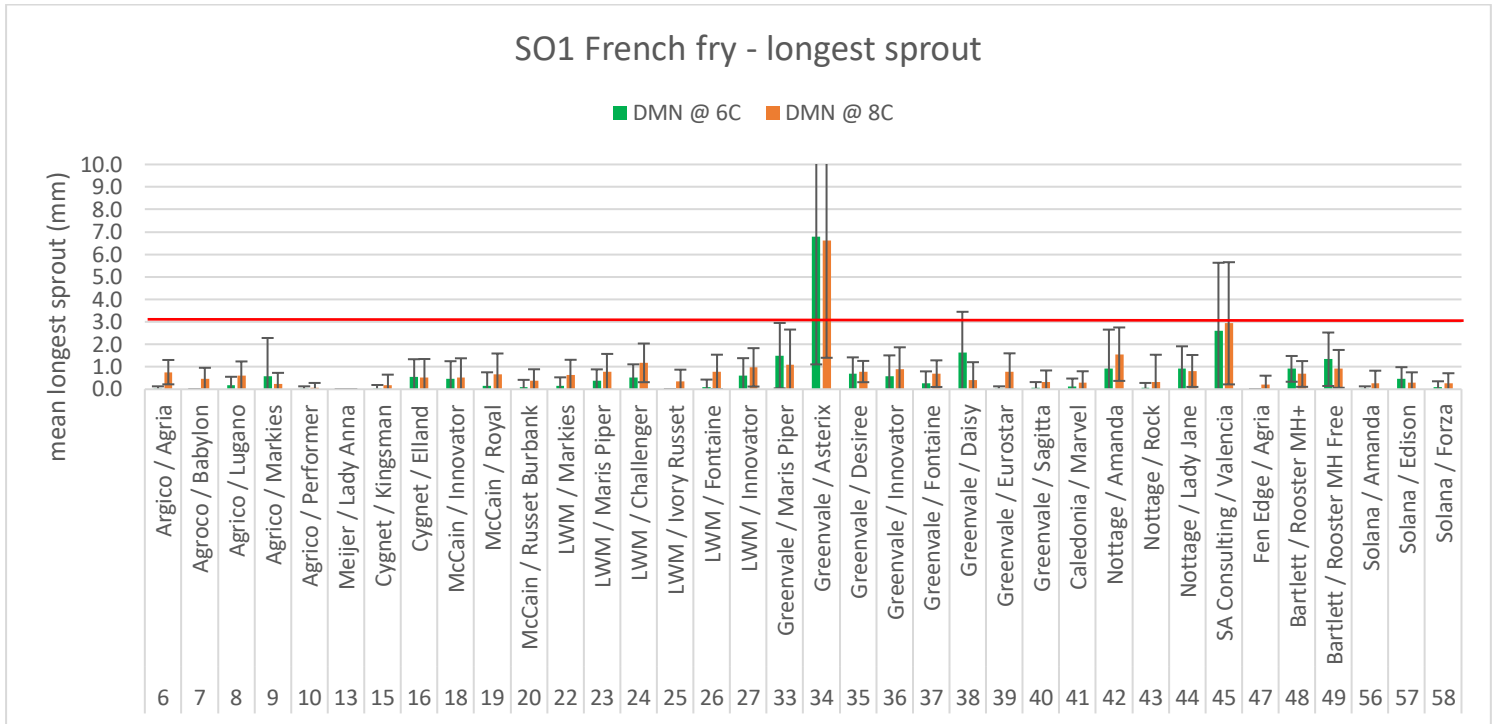


Weight Loss



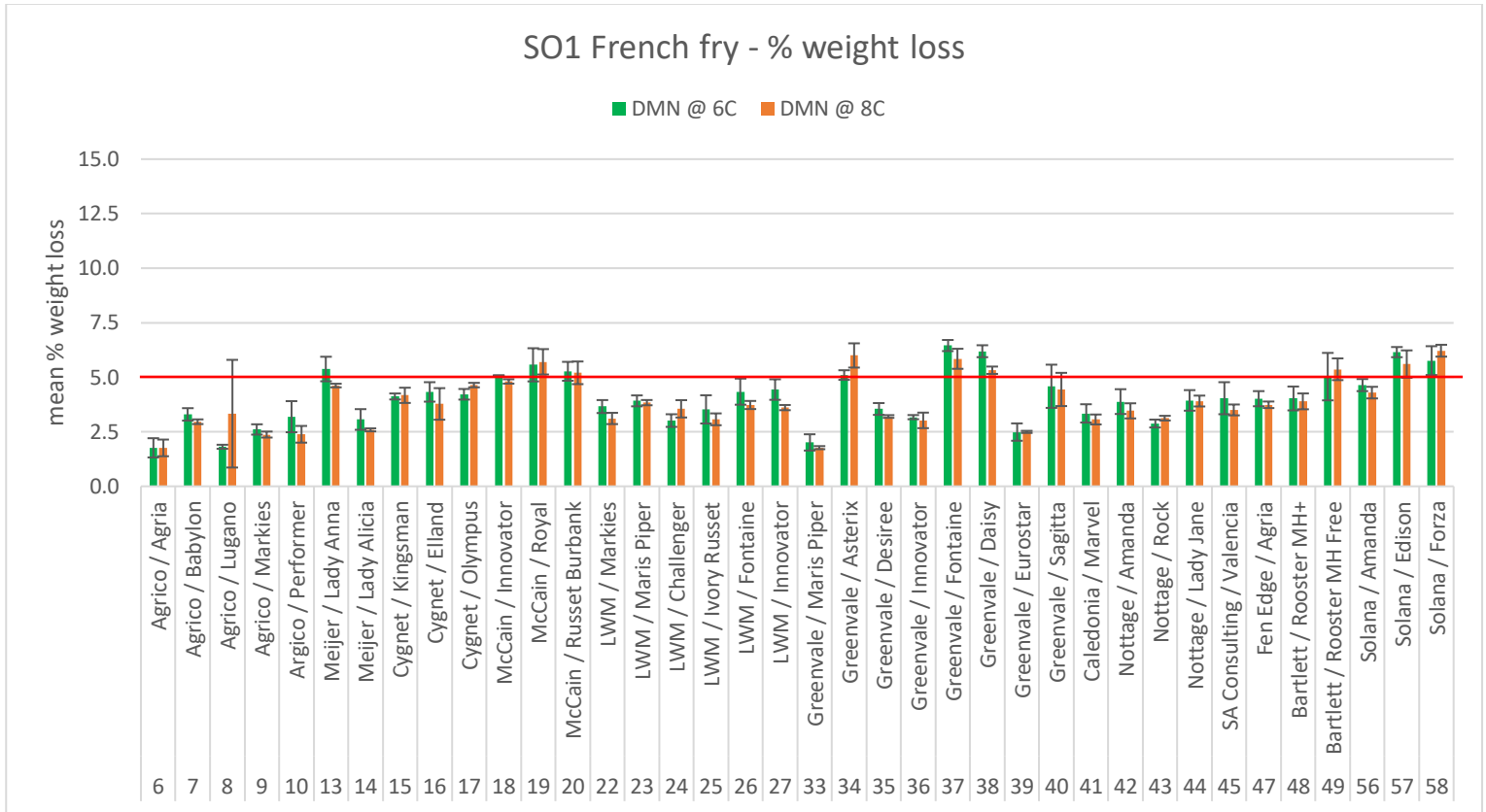
SAMPLING OCCASION 1 (Experiment 1): from 9th February 2021

French Fry



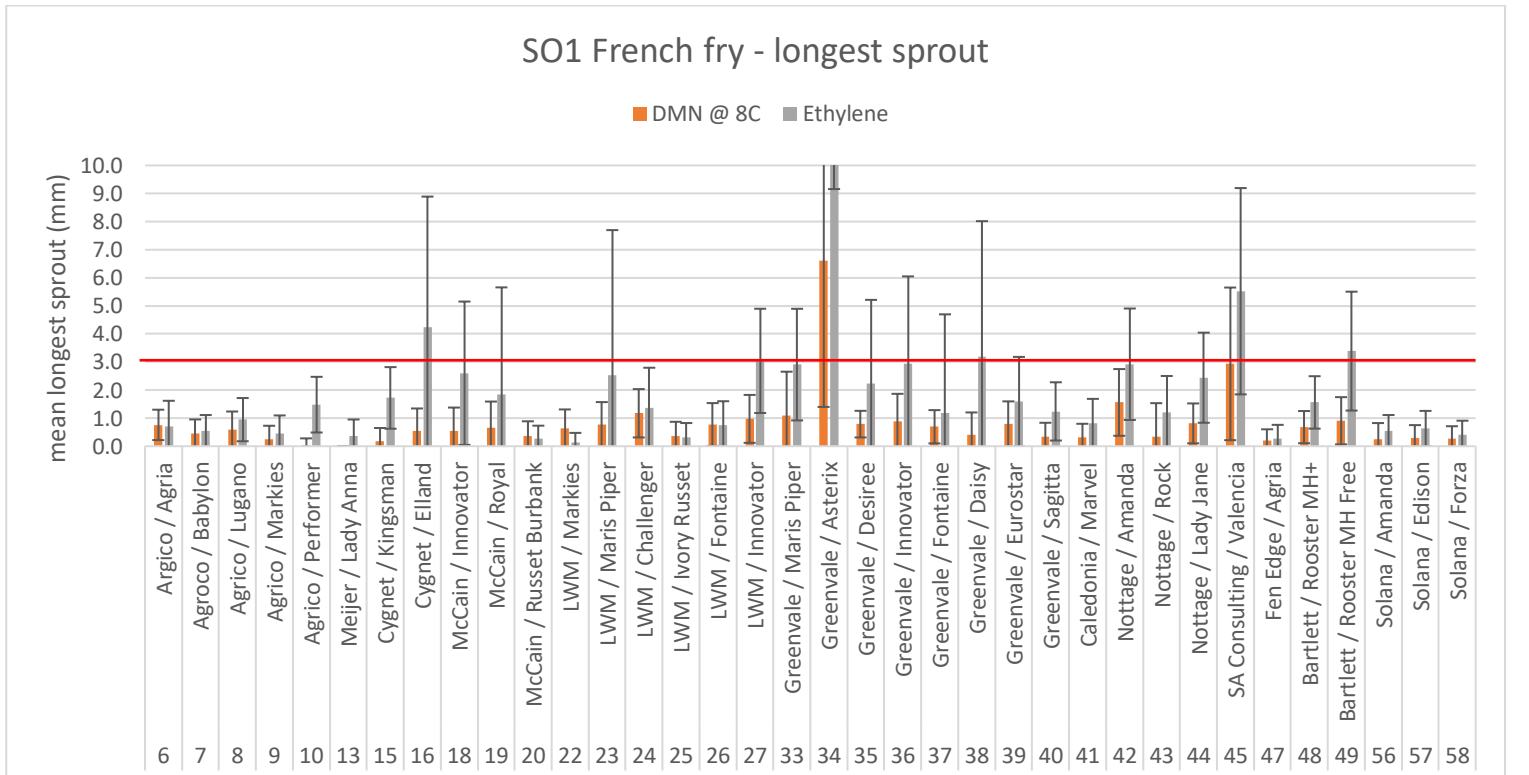
Note: *Stocks 14 & 17 were fried as French Fry in error – should have been crisps

Weight loss

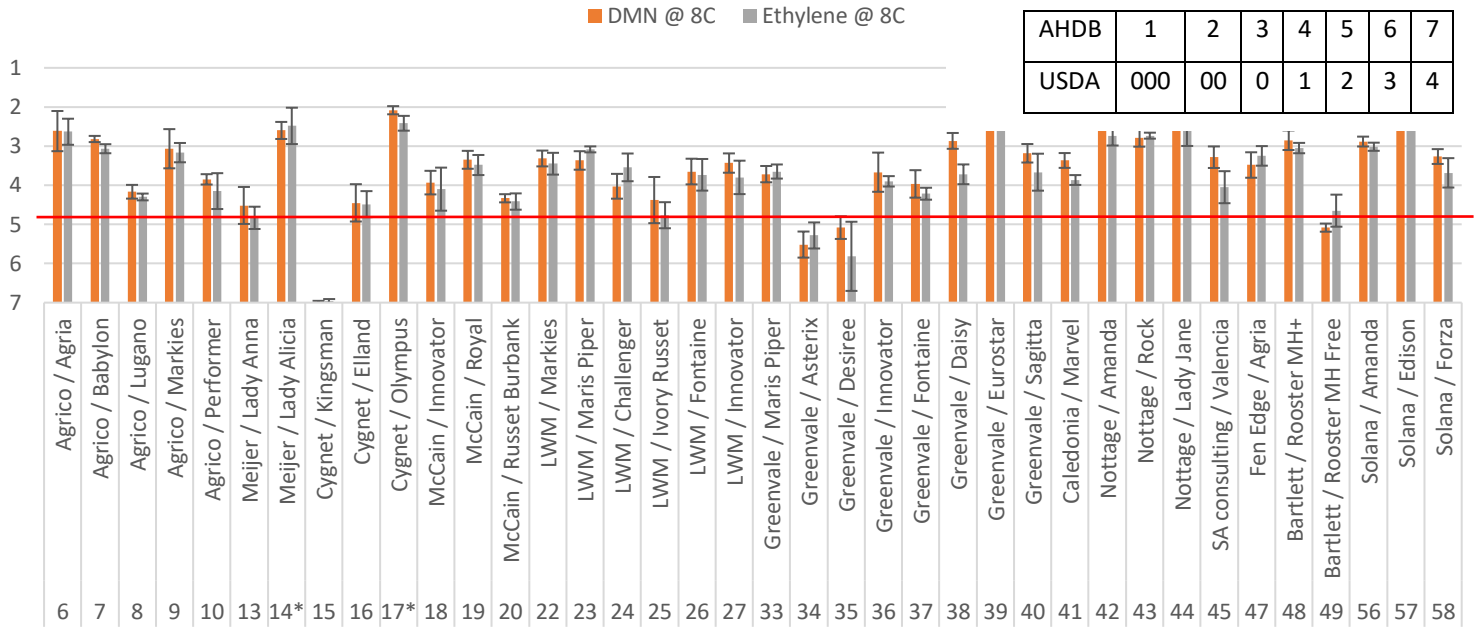


SAMPLING OCCASION 1 (Experiment 2): from 9th February 2021

French Fry



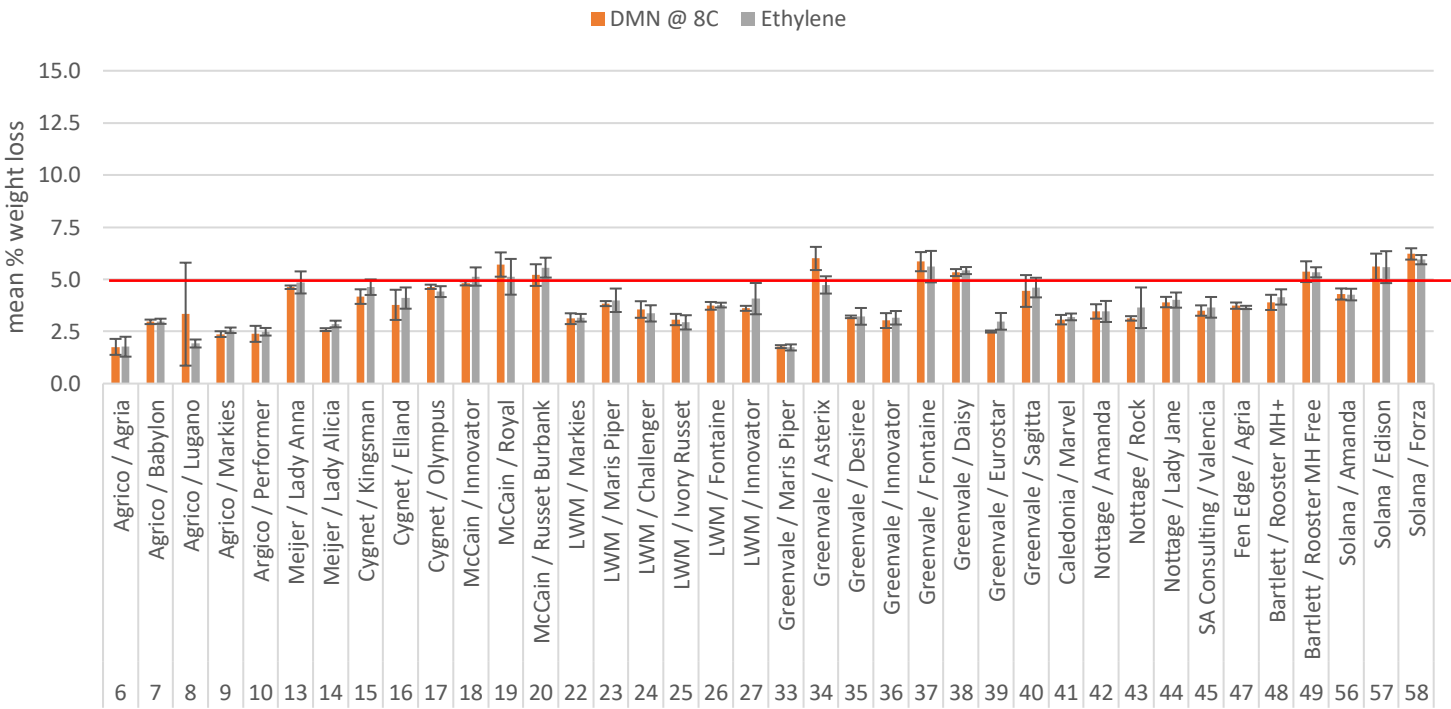
SO1 - French fry colour



*Stocks 14 & 17 fried as French Fry in error – should have been crisps

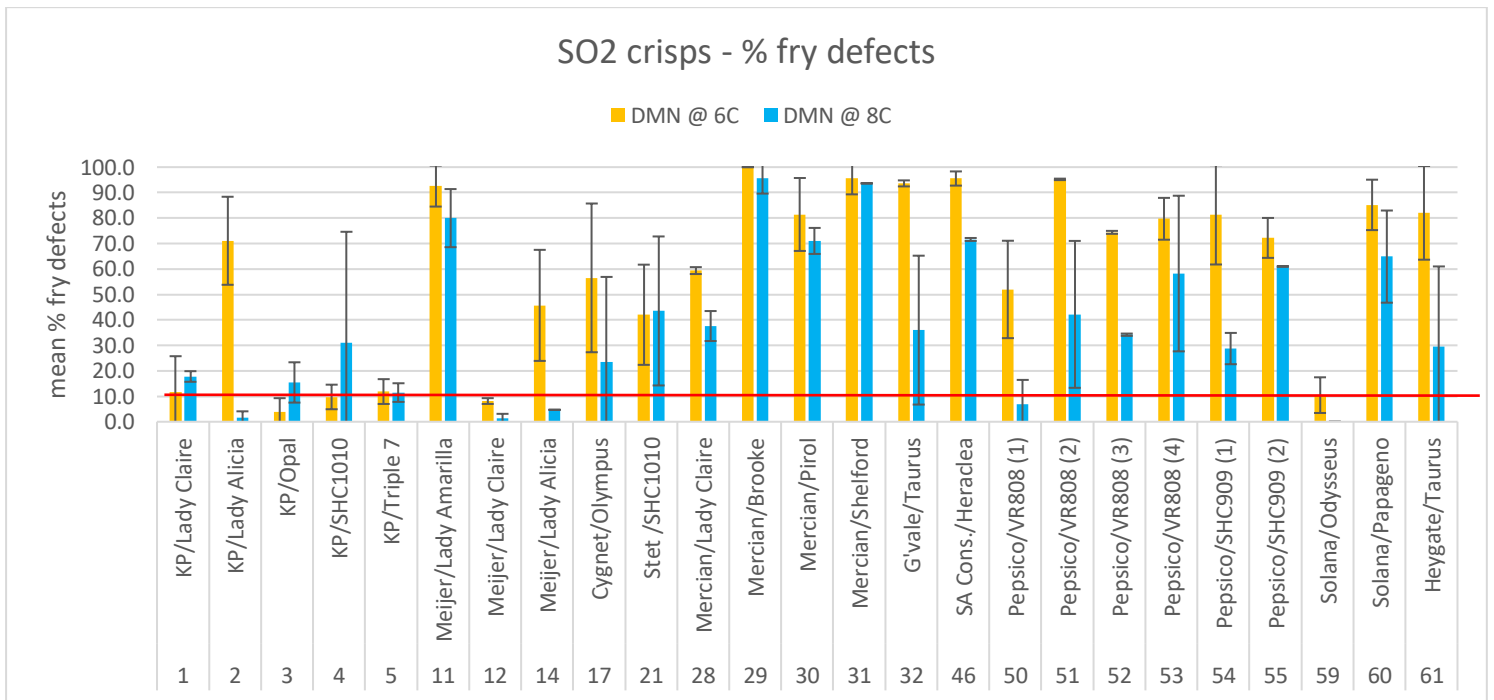
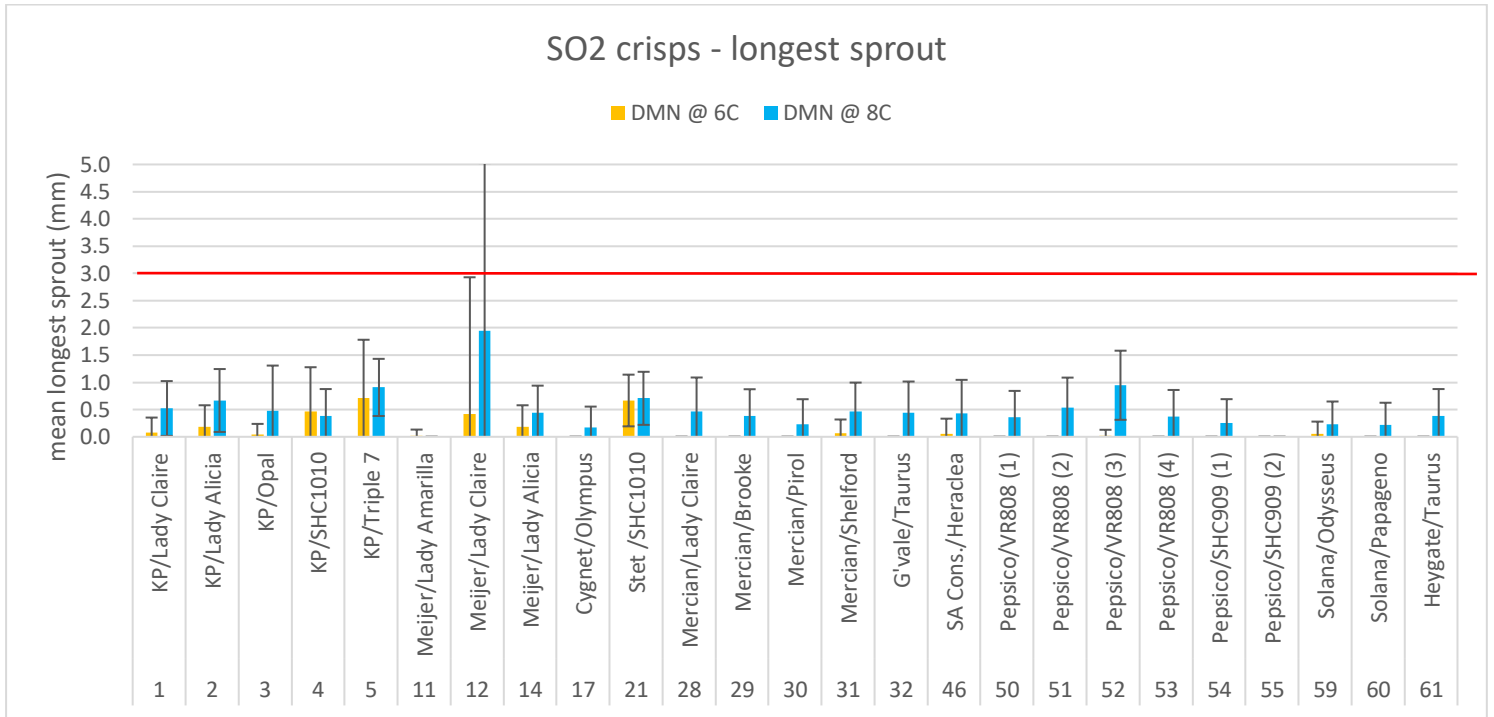
Weight loss

SO1 French fry - % weight loss

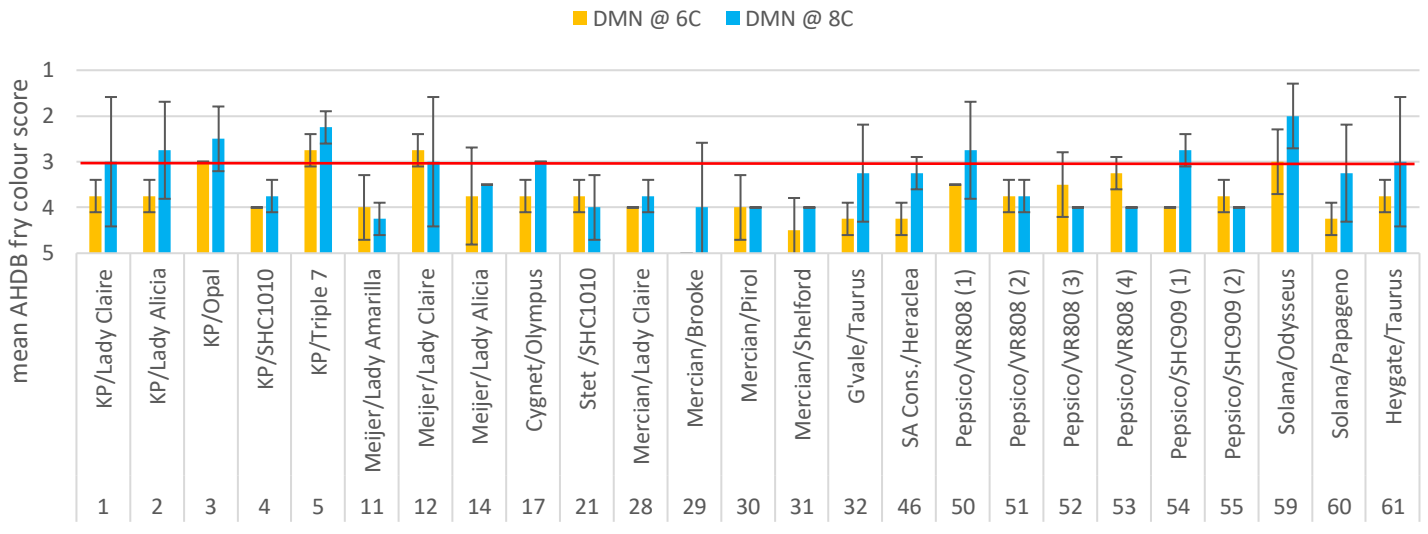


SAMPLING OCCASION 2 (Experiment 1) (from 25th May 2021)

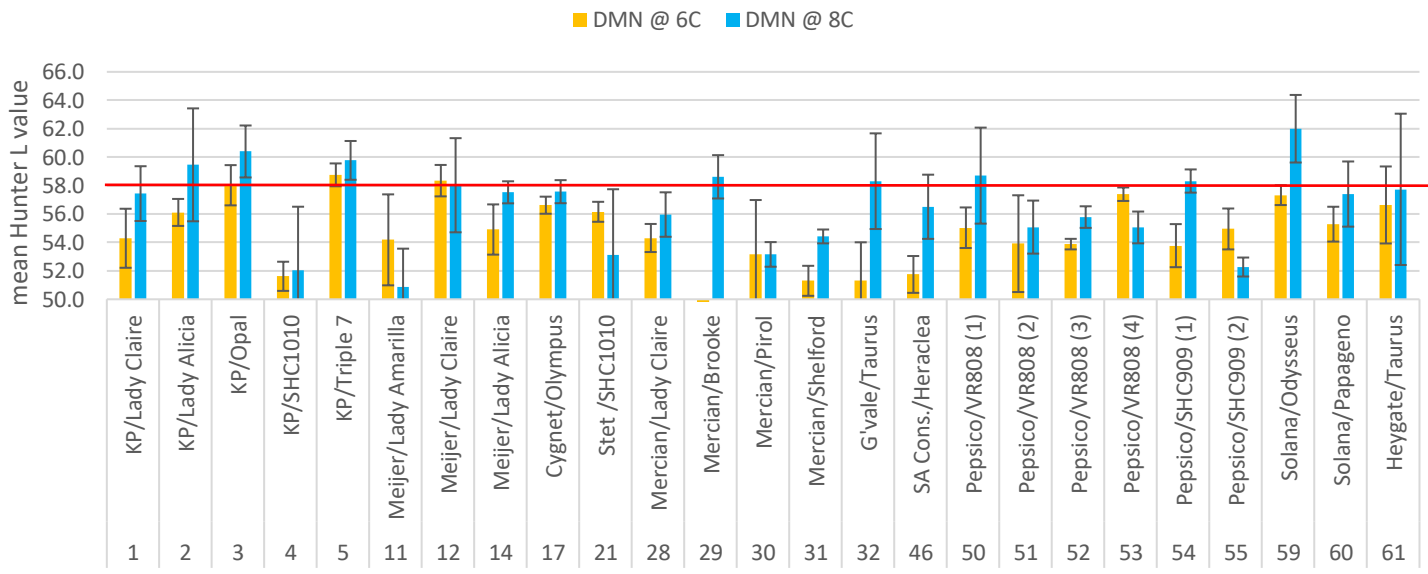
Crisps



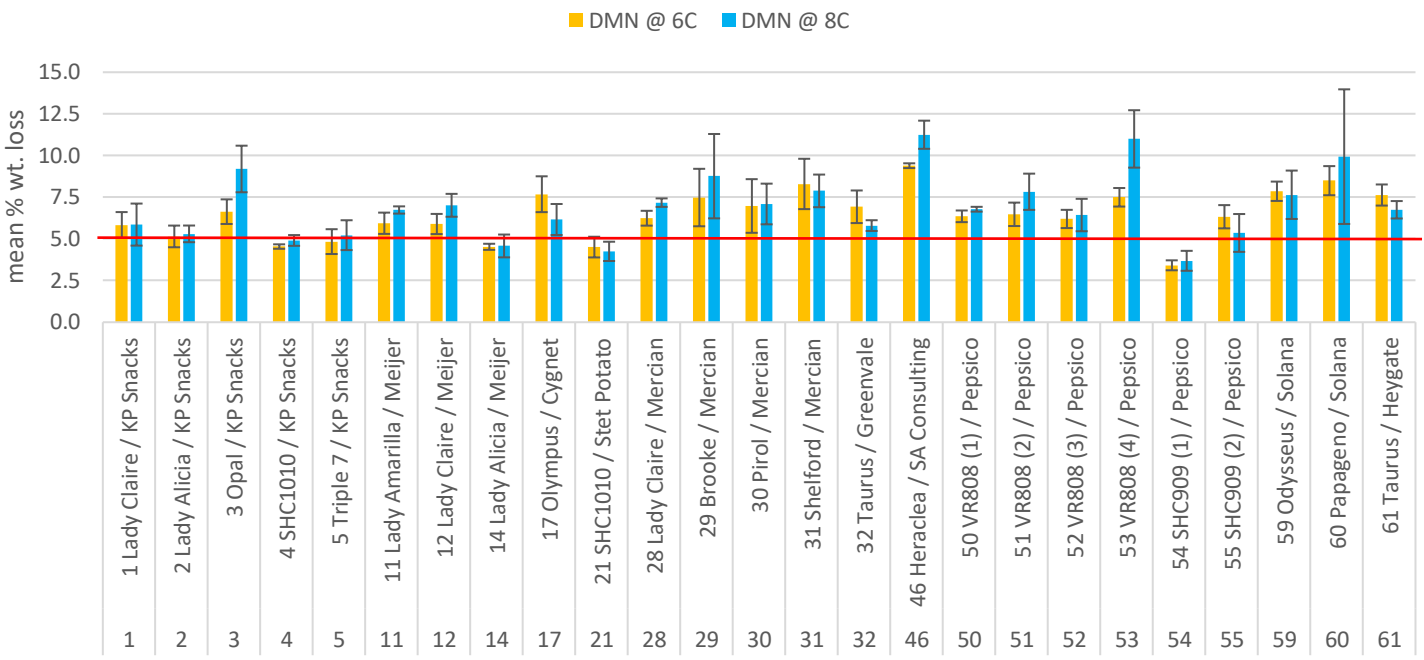
SO2 crisps - fry colour



SO2 crisps - Hunter L value

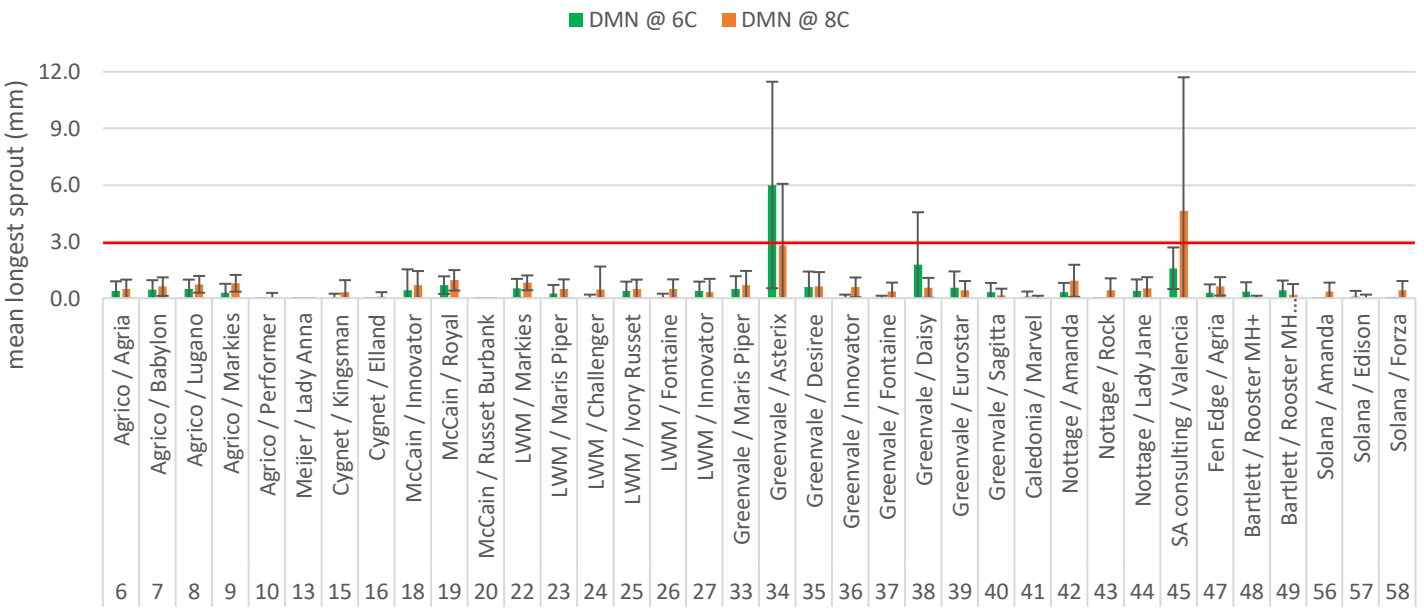


SO2 crisps - % wt. loss



French fry

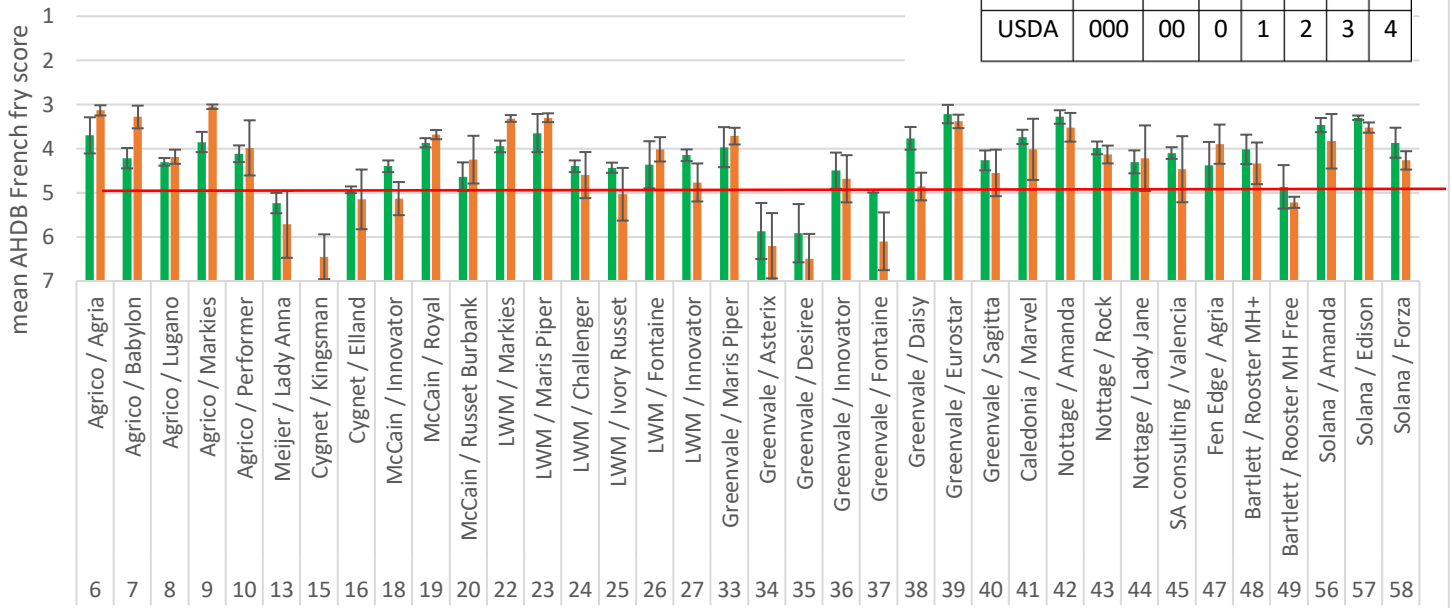
SO2 French fry - longest sprout



SO2 - French fry score

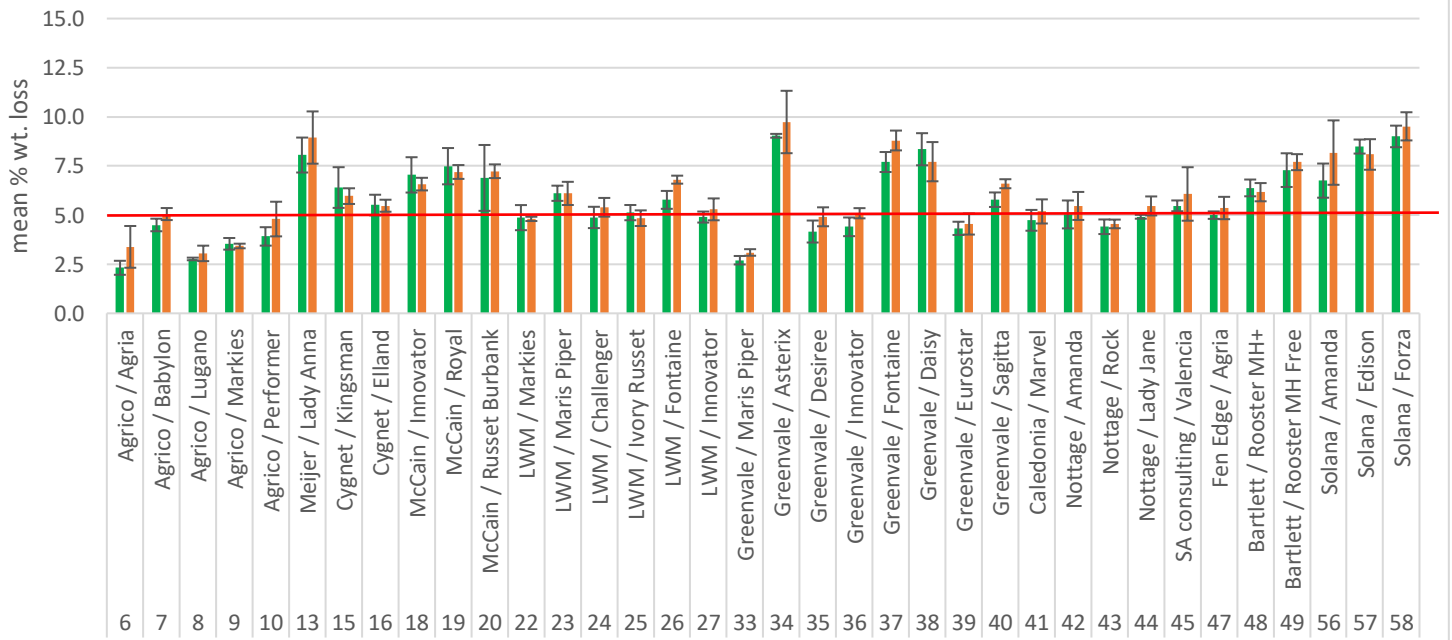
■ DMN @ 6C ■ DMN @ 8C

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



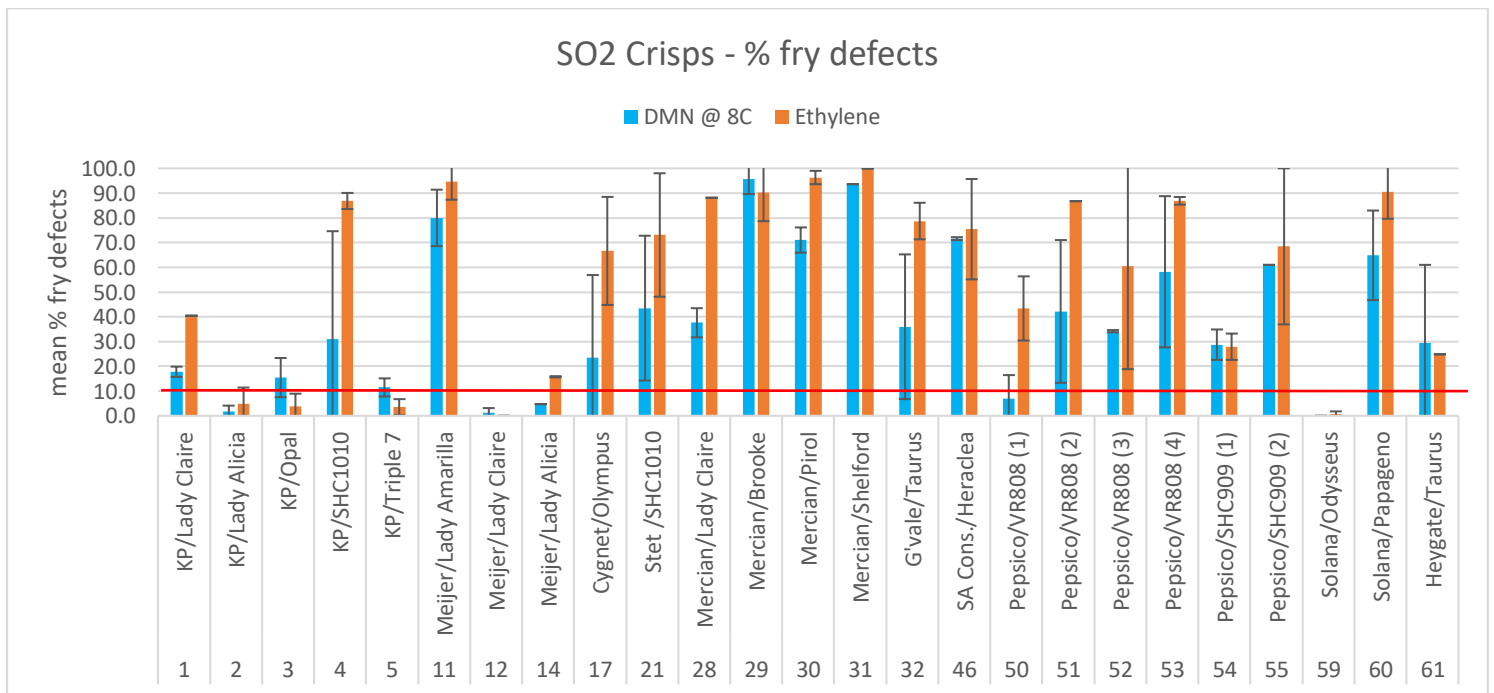
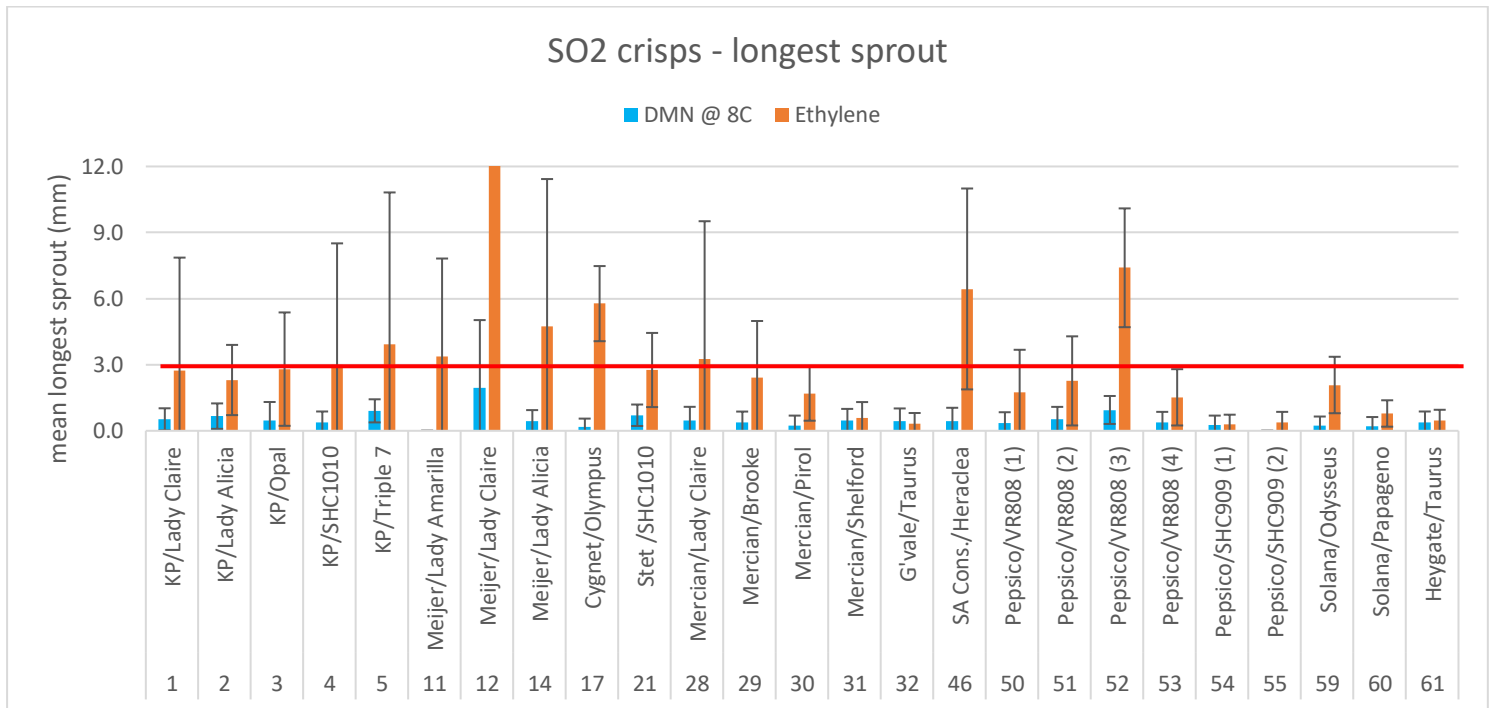
SO2 French fry - % wt. loss

■ DMN @ 6C ■ DMN @ 8C

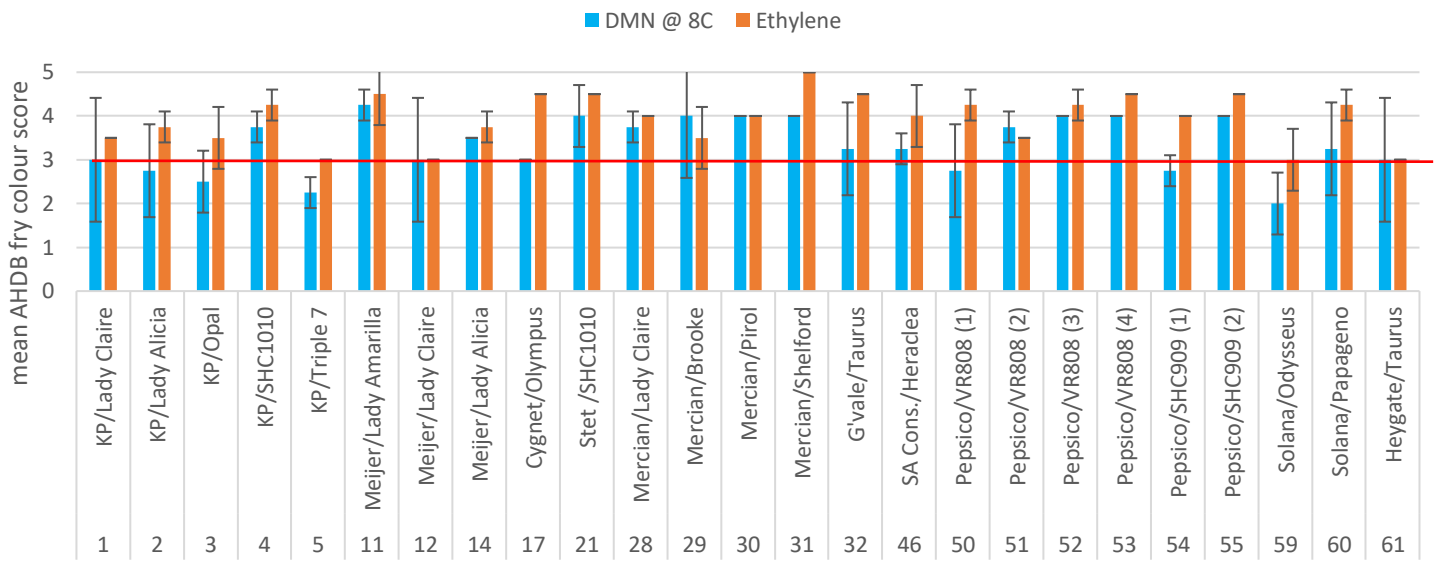


SAMPLING OCCASION 2 (Experiment 2) (from 25th May 2021)

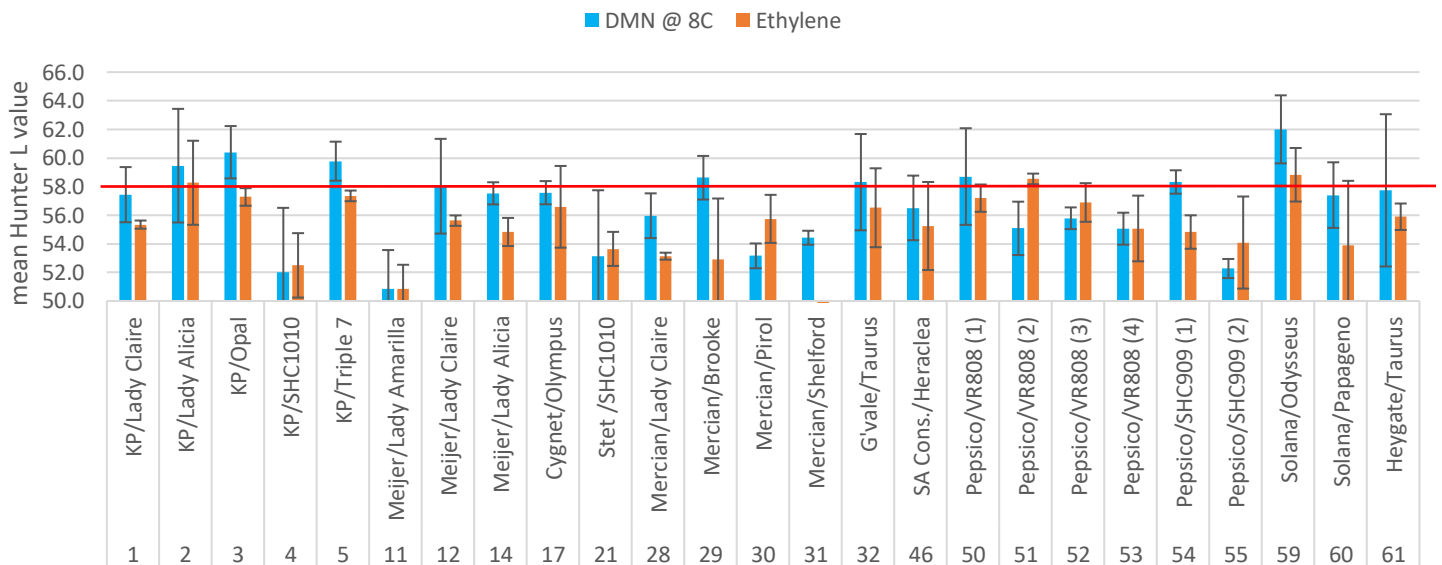
Crisps



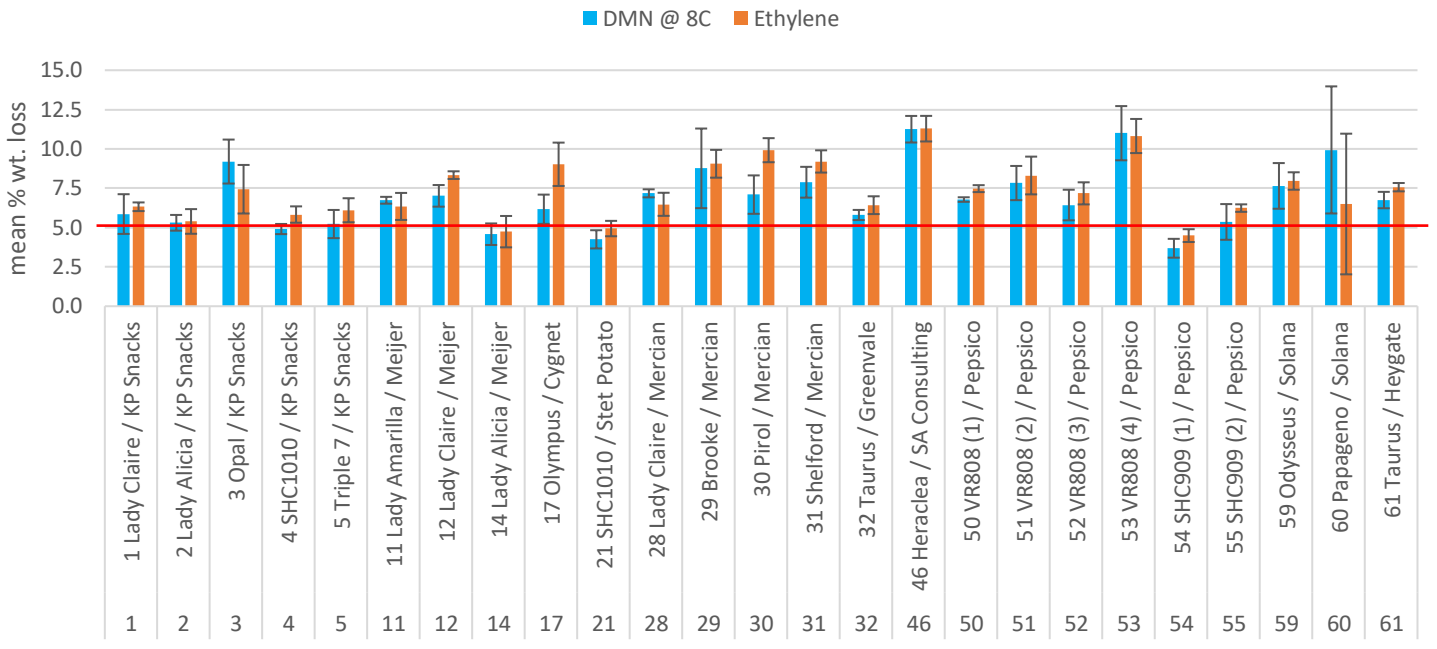
SO2 crisps - fry colour



SO2 crisps - Hunter L value

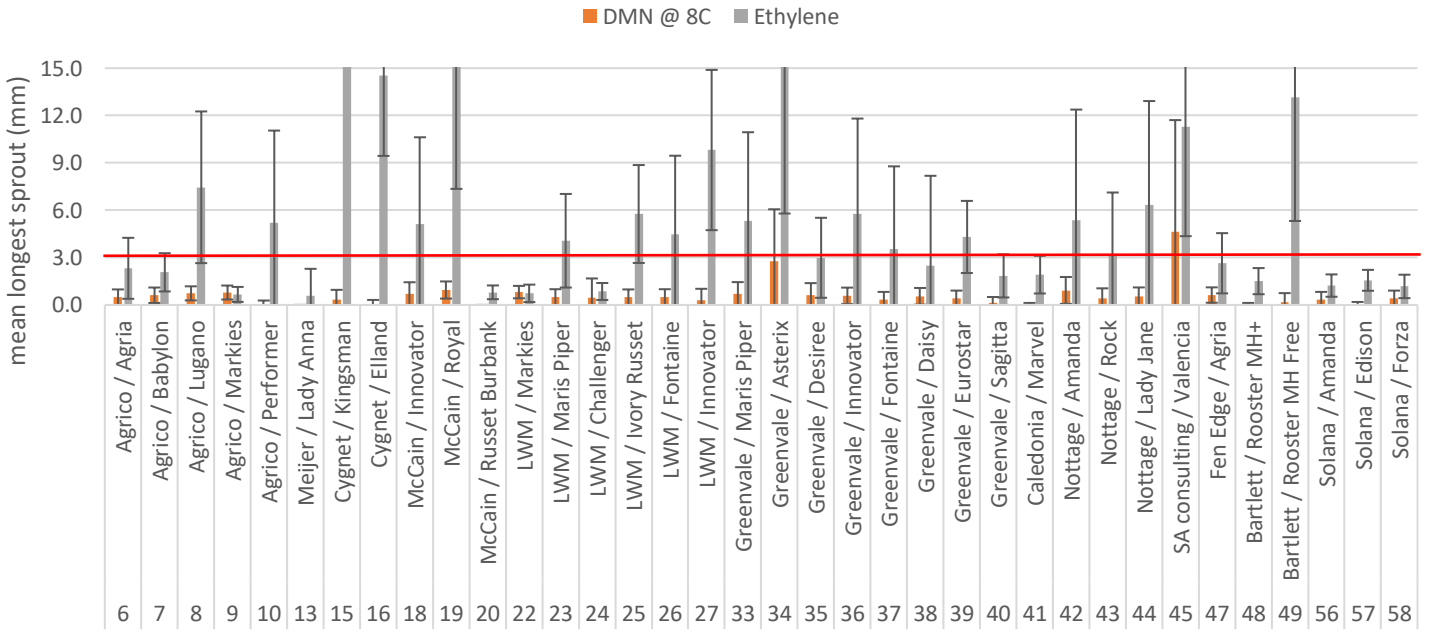


SO2 crisps - % wt. loss



French Fry

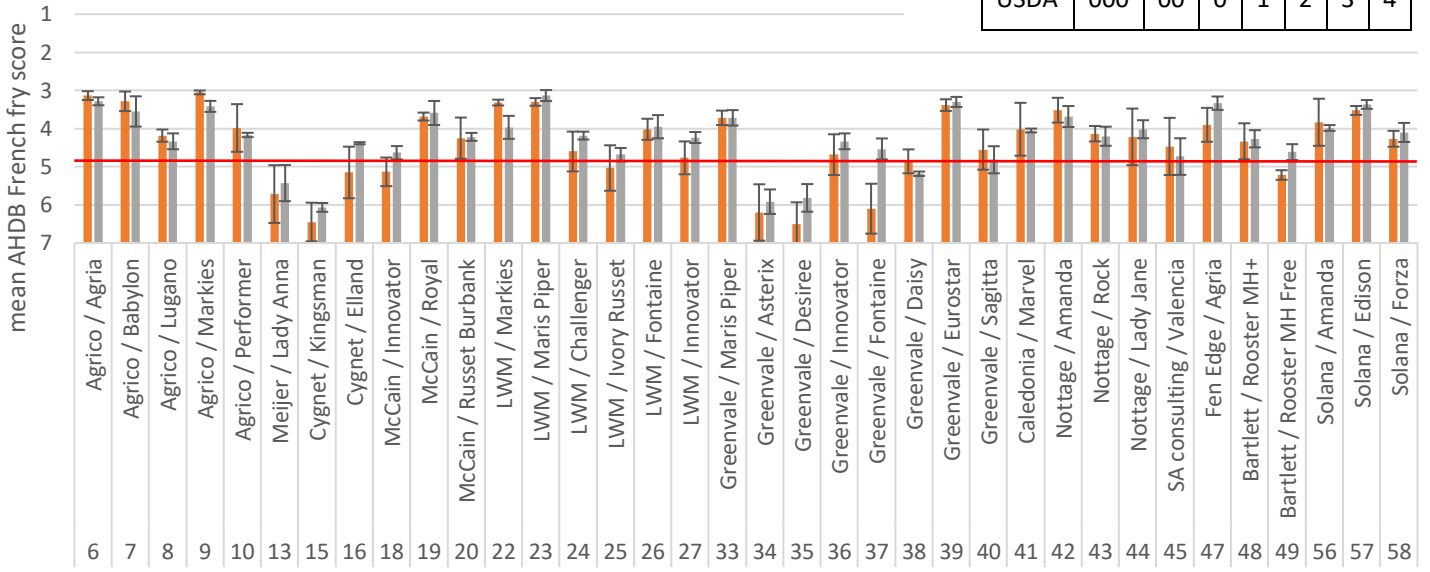
SO2 French fry - longest sprout



SO2 - French fry score

DMN @ 8C Ethylene

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



SO2 French fry - % wt. loss

DMN @ 8C Ethylene

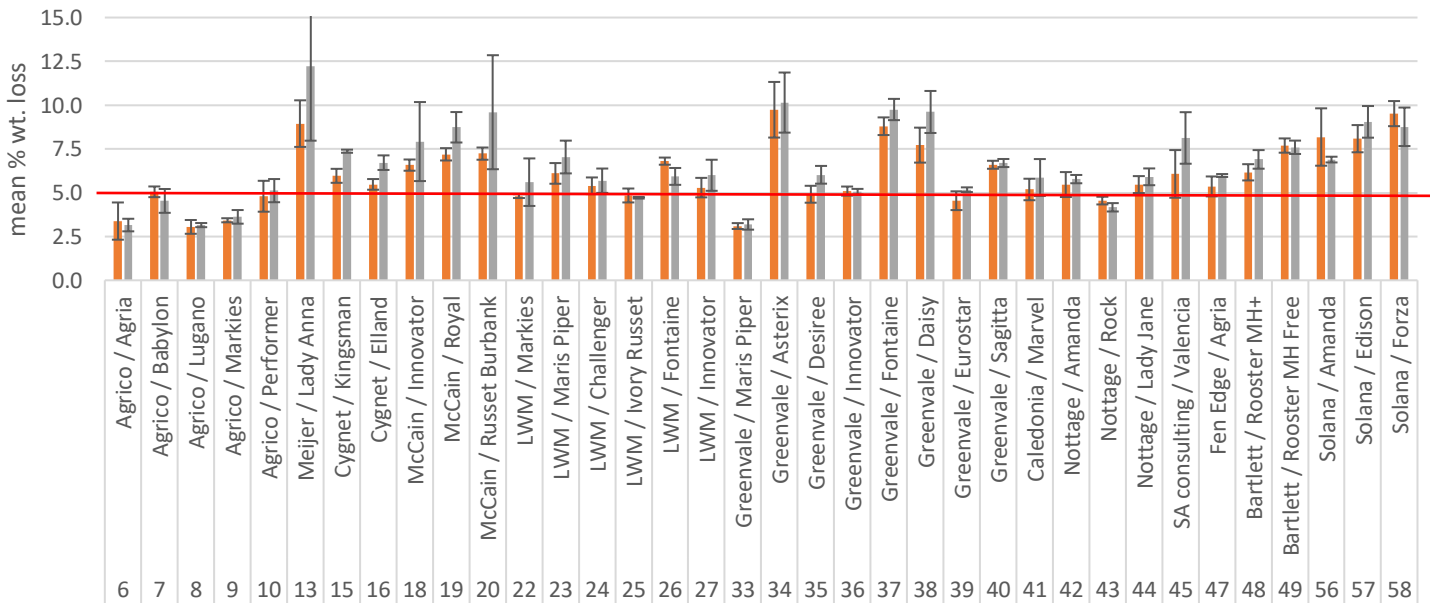


Table 5. Crisping varieties: successful storage

*	Defects <50%
*	Light cabinet <3
*	Hunter L >58

Stock	Variety	Supplier	Intake	A/S 15 weeks			A/S 30 weeks		
				DMN @ 6C	DMN @ 8C	Ethylene	DMN @ 6C	DMN @ 8C	Ethylene
1	Lady Claire	KP Snacks	***	*	***	**	*	**	*
2	Lady Alicia	KP Snacks	***	*	**	***		***	**
3	Opal	KP Snacks	***	***	***	***	***	***	*
4	SHC1010	KP Snacks	***	***	***	***	*	*	
5	Triple 7	KP Snacks	***	***	***	***	***	**	**
11	Lady Amarilla	Meijer	***		*	*			
12	Lady Claire	Meijer	***	***	***	***	***	***	**
14	Lady Alicia	Meijer	***				*	*	*
17	Olympus	Cygnat	***					**	
21	SHC1010	Stet Potato	***	**	*	**	*	*	
28	Lady Claire	Mercian	***		*	*		*	
29	Brooke	Mercian	***					*	
30	Pirol	Mercian	***	*	*	*			
31	Shelford	Mercian	***	*	*	*			
32	Taurus	Greenvale	***	*	*			**	
46	Heraclea	SA Consulting	***	**	***	***			
50	VR808 (1)	Pepsico	***	***	***	***		***	*
51	VR808 (2)	Pepsico	***		*	*		*	*
52	VR808 (3)	Pepsico	***		*	**		*	
53	VR808 (4)	Pepsico	***	*	***	*			
54	SHC909 (1)	Pepsico	***	*	***	*		***	*
55	SHC909 (2)	Pepsico	***	*	*	*			
59	Odysseus	Solana	***	***	***	***	**	***	***
60	Papageno	Solana	***	*	*	*			
61	Taurus	Heygate	***	*	***	*		**	**

Only stocks achieving at least one triple * rating after storage (A/S) are highlighted.

Table 6. French fry varieties:

Rating	FF Score
***	<3
**	<4
*	<5

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

Stock	Supplier/ Variety	Intake	A/S 15 weeks			A/S 30 weeks		
			DMN @ 6C	DMN @ 8C	Ethylene	DMN @ 6C	DMN @ 8C	Ethylene
6	Agrico / Agria	***	*	***	***	**	**	**
7	Agrico / Babylon	***	*	***	**	*	**	**
8	Agrico / Lugano	***	*	*	*	*	*	*
9	Agrico / Markies	***	**	**	**	**	**	**
10	Agrico / Performer	***	*	**	*	*	**	*
13	Meijer / Lady Anna	***		*	*			
14	Meijer / Lady Alicia*		**	***	***			
15	Cygnnet / Kingsman	**						
16	Cygnnet / Elland	**	*	*	*	*		*
17	Cygnnet / Olympus*		**	***	***			
18	McCain / Innovator	***	*	**	*	*		*
19	McCain / Royal	***	*	**	**	**	**	**
20	McCain / Russet Burbank	**		*	*	*	*	*
22	LWM / Markies	***	*	**	**	**	**	**
23	LWM / Maris Piper	***	*	**	**	**	**	**
24	LWM / Challenger	***		*	**	*	*	*
25	LWM / Ivory Russet	***	*	*	*	*		*
26	LWM / Fontaine	***	*	**	**	*	*	**
27	LWM / Innovator	***	*	**	**	*	*	*
33	Greenvale / Maris Piper	***	*	**	**	**	**	**
34	Greenvale / Asterix	***						
35	Greenvale / Desiree	**						
36	Greenvale / Innovator	***	*	**	**	*	*	*
37	Greenvale / Fontaine	***		**	*	*		*
38	Greenvale / Daisy	***	**	***	**	**	*	
39	Greenvale / Eurostar	***	***	***	***	**	**	**
40	Greenvale / Sagitta	***	**	**	**	*	*	*
41	Caledonia / Marvel	***	*	**	**	**	*	*
42	Nottage / Amanda	***	**	***	***	**	**	**
43	Nottage / Rock	***	**	***	***	**	*	*
44	Nottage / Lady Jane	***	**	***	***	*	*	*
45	SA / Valencia	***	**	**	*	*	*	*

Stock	Supplier/ Variety	Intake	A/S 15 weeks			A/S 30 weeks		
			DMN @ 6C	DMN @ 8C	Ethylene	DMN @ 6C	DMN @ 8C	Ethylene
47	Fen Edge / Agria	***	*	**	**	*	**	**
48	Bartlett / Rooster MH+	***	**	***	**	*	*	*
49	Bartlett / Rooster MH Free	***			*	*		*
56	Solana / Amanda	***	**	***	**	**	**	**
57	Solana / Edison	***	***	***	***	**	**	**
58	Solana / Forza	***	**	**	**	**	*	*

*Stocks 14 & 17 fried as French Fry in error – should have been crisps.

Only stocks achieving at least one triple * rating after storage (A/S) are highlighted.

5. Discussion

This trial formed the second (and final) year of this work to look at varietal performance in relation to storage (a) at lower temperatures for processing and (b) the use of ethylene as a sprout suppressant for processing varieties.

Stocks for this work were submitted by industry organisations from around the country. The danger with such multi-stock trials is that site/season variability can rapidly exceed any treatment differences. This trial certainly suffered from some unexpected variation in that regard, with many stocks failing to make the grade, especially after 30 weeks' long-term storage, highlighting the need for specific management for each crop when stored commercially.

In the 2019/20 trial, several varieties produced both a positive outcome to ethylene treatment and were also able to be stored successfully at cooler temperature, especially for longer term storage (30 weeks). A small number of varieties responded to ethylene without responding very well to storage at 6°C; a few did not respond to ethylene but did give satisfactory storage under the cooler storage regime.

In this year's work there were similar trends observed, although quality out of store was generally poorer. This meant that the differences between varietal responses were perhaps a bit exaggerated which helped to show which varieties were truly robust under the test regimes.

It must be repeated that there was a high degree of variation in the data so any analysis has to be exercised with caution. As in year 1, stocks of the same variety did behave differently and this was not unexpected given the significant variation in harvest date and crop condition on intake.

Good performers of note were Lady Claire, Odysseus, Opal, Triple 7 and VR808 in the crisping lots, whereas Edison and Eurostar were the most consistent of the chipping stocks. Amanda, Lady Jane and Rock showed up well under ethylene in short term (15 weeks) storage.

What the trial does highlight, quite strongly, is that there are a lot of varieties which – even allowing for the vagaries of site and season – are not really performing that well in storage even under 'standard conditions' (in this case the DMN-treated 8°C control) let alone under the more testing environments of cooler temperature or ethylene. But there are some specific cultivars which do perform consistently well and it should be varieties with those traits that should be given more serious consideration as the basis for long term storage in the future. Many of the stocks held in storage spend longer in the store than they do as a growing crop, so it is important to recognise that in selecting the most appropriate varieties for storage under these new regimes. Sustaining the old crops which need more chemical input and are prone to higher storage losses will not be economically viable in future.

6. Acknowledgements

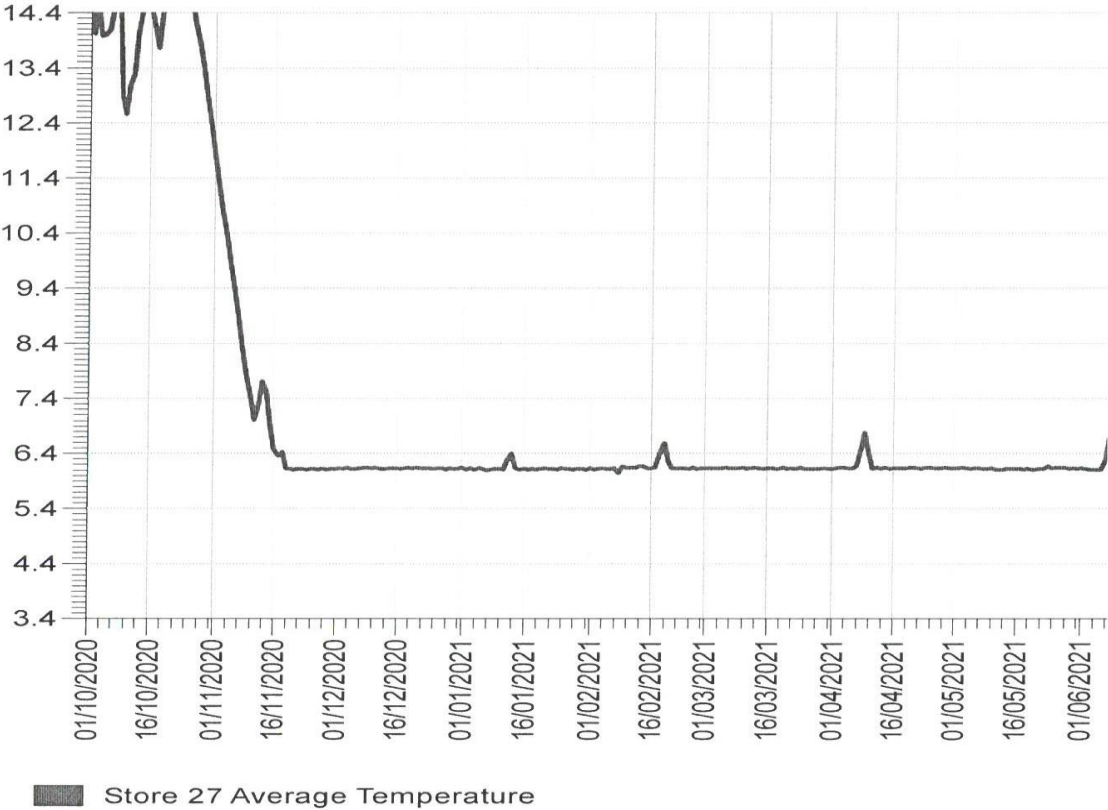
AHDB is grateful to all of the organisations who helped to provide stocks for this trial. Thanks also to DormFresh Ltd for allowing use of (as yet unapproved) 1,4-DMN treatments for sprout suppression in the colder storage and control regimes.

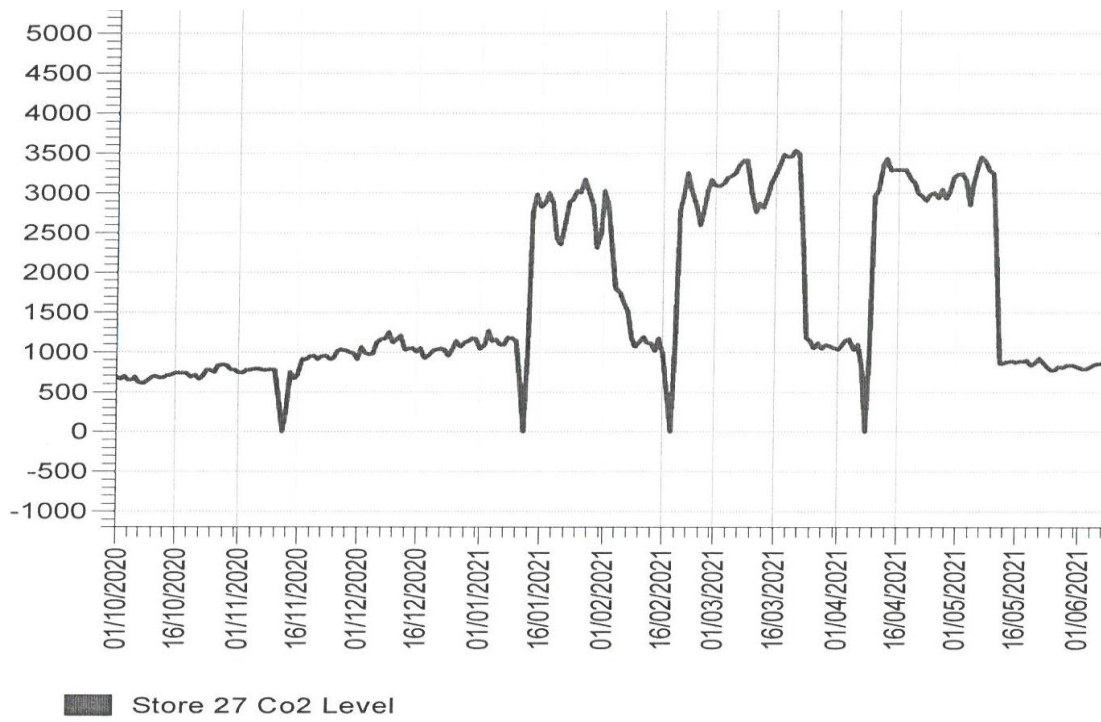
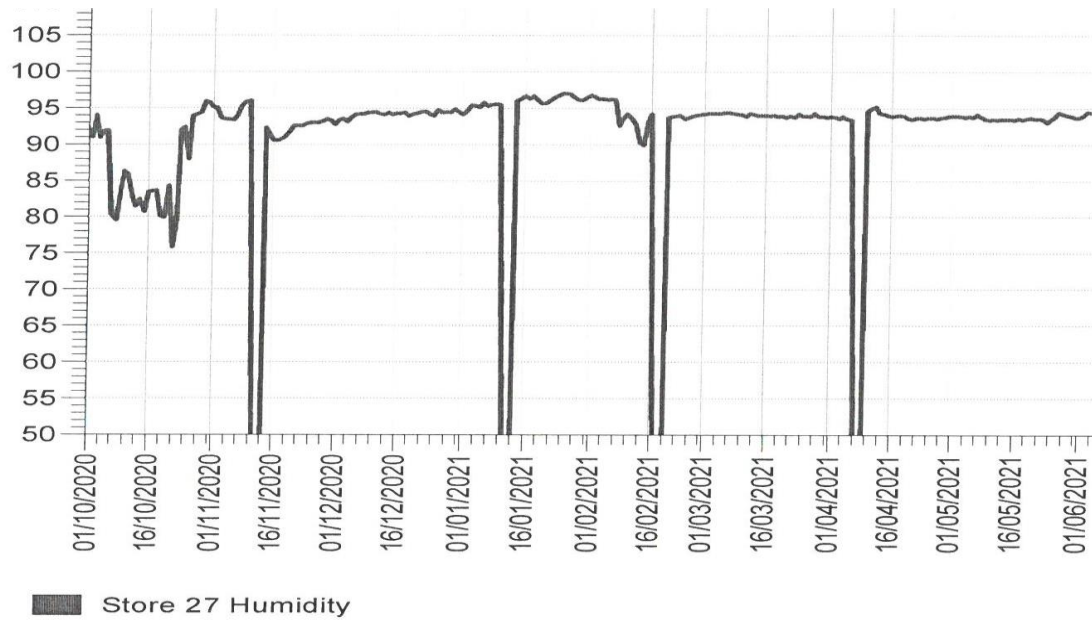
This trial will now conclude as part of the wind-down measures imposed following the loss of levy-funding to AHDB Potatoes and the consequential closure of Sutton Bridge CSR in December 2021.

Appendix

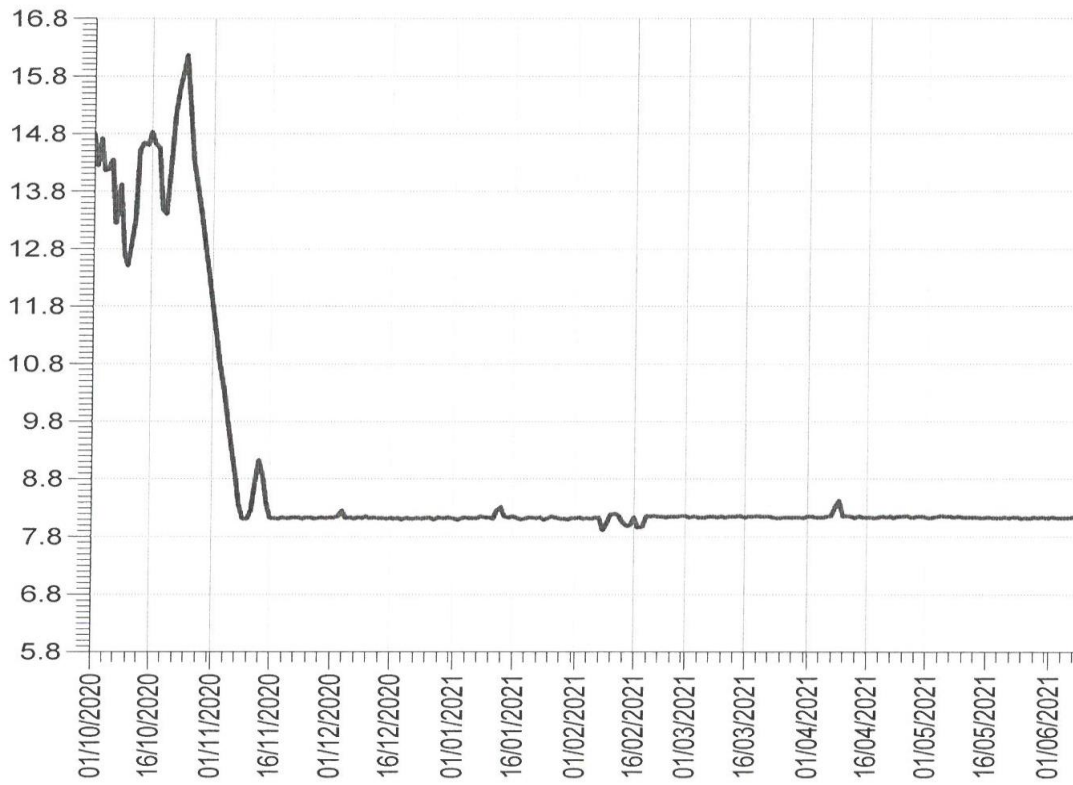
Storage conditions

DMN @6C store:

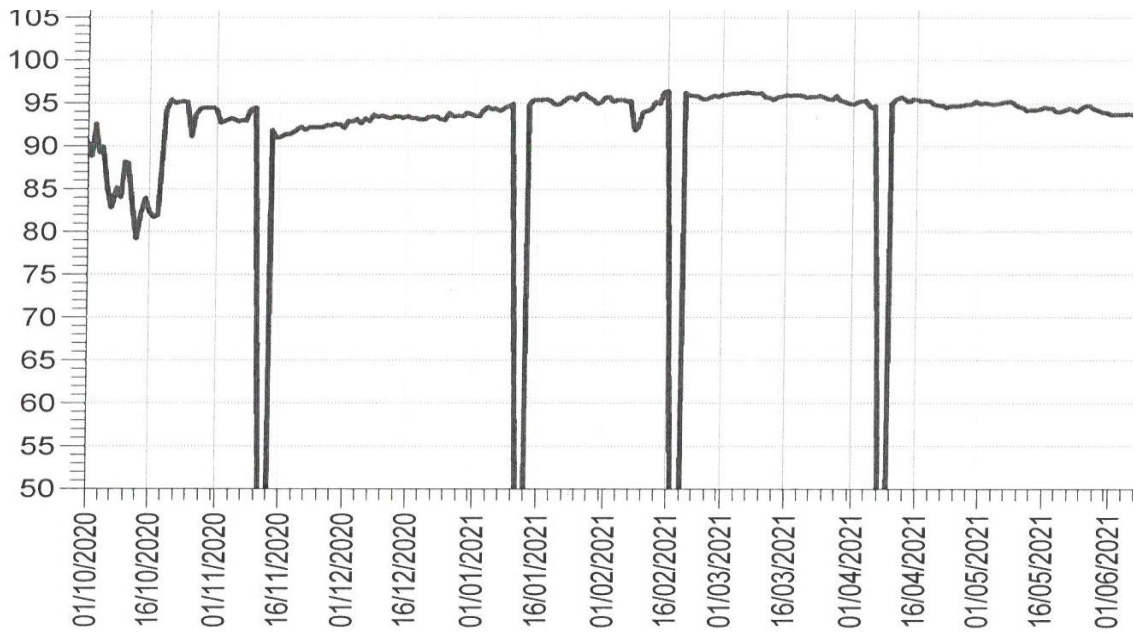




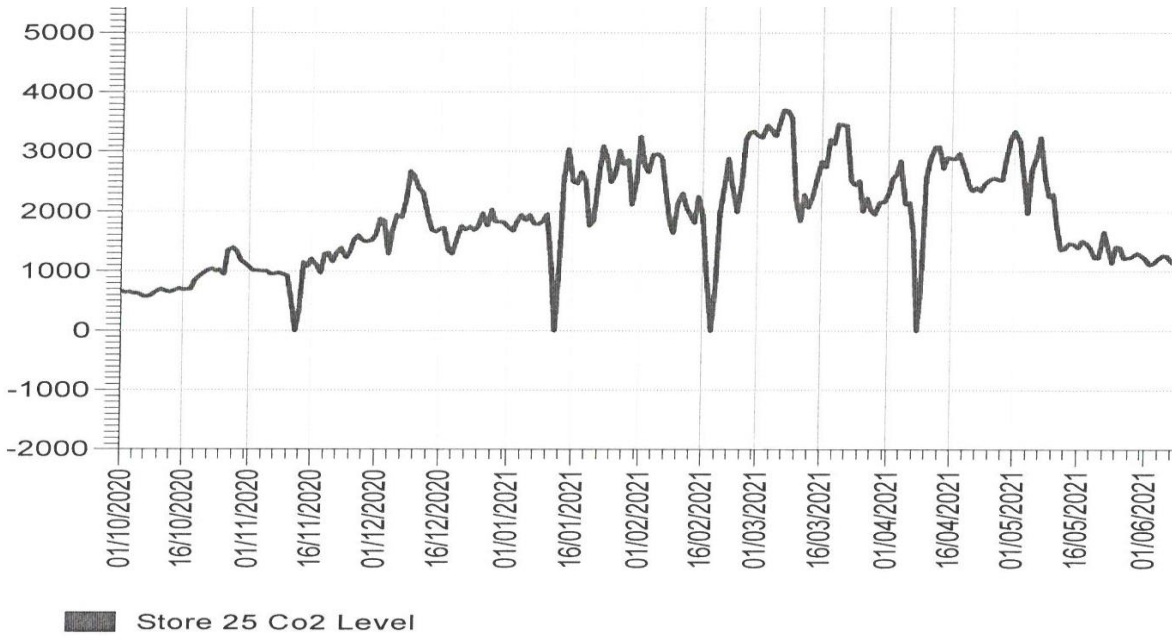
DMN@8C store:



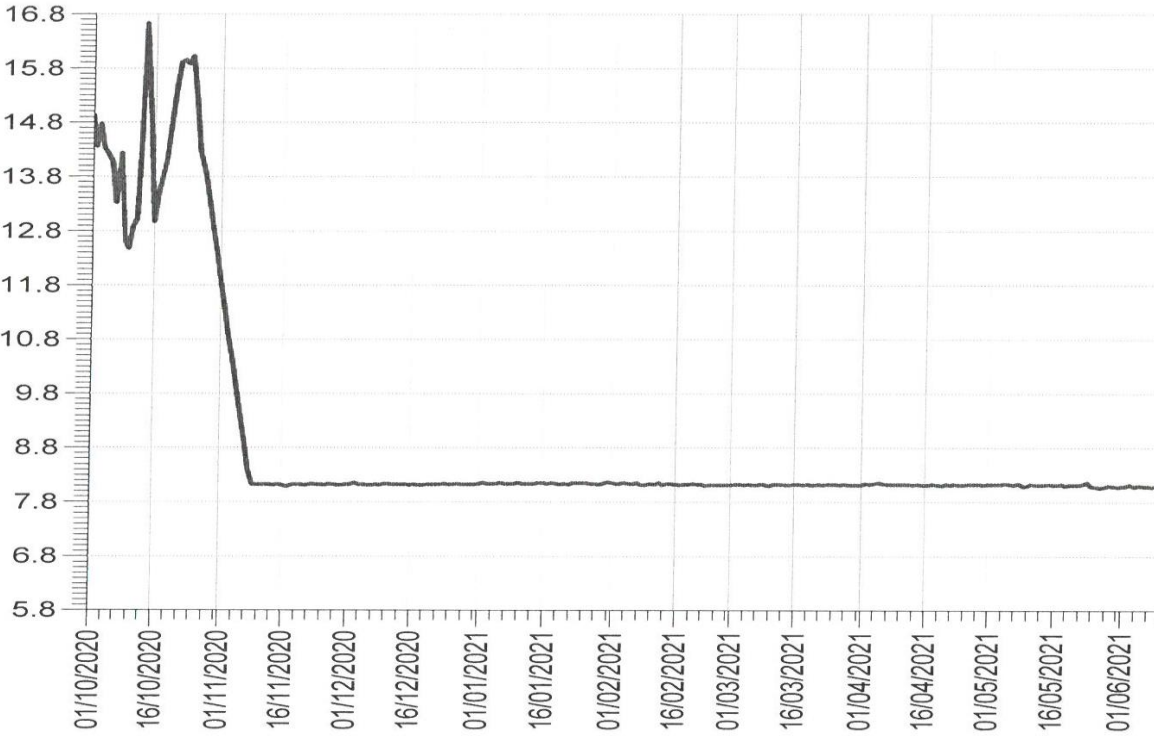
Store 25 Average Temperature



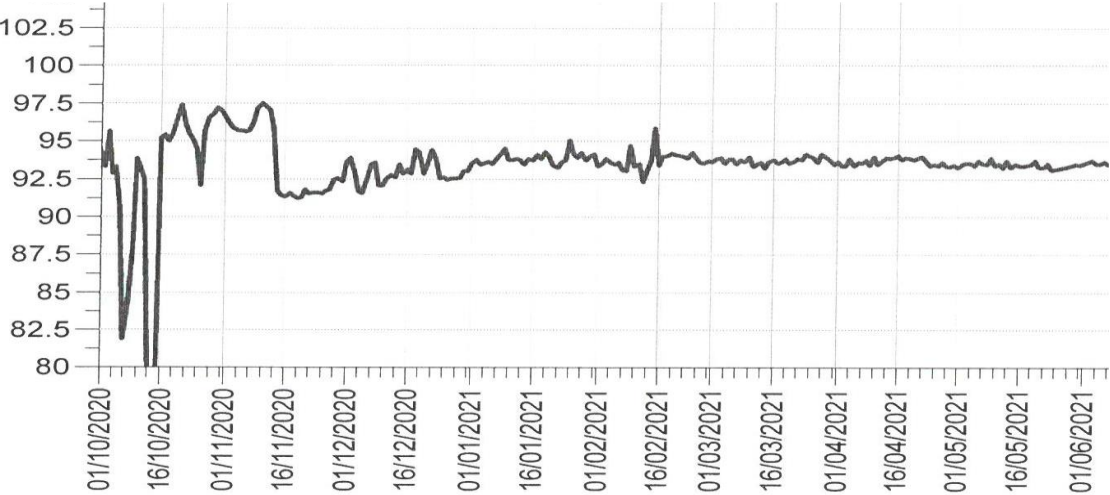
Store 25 Humidity



Ethylene store:



Store 26 Average Temperature



Store 26 Humidity

