INTERIM SUMMARY REPORT

Assessment of maleic hydrazide as a potato sprout suppressant

AHDB Potatoes
Sutton Bridge Crop Storage Research
East Bank, Sutton Bridge
Spalding, Lincs. PE12 9YD
Tel: 01406 351444 Fax: 01406 351125
E-mail: sbcsr@ahdb.org.uk

Report Author: A Cunnington

S1056 (2018/19) **Date submitted: March 2020**

1 Introduction

This trial was established as part of AHDB work to optimise the performance of potato sprout suppressants during storage.

Maleic hydrazide (MH) forms part of a portfolio of alternatives to the long-established suppressant of choice, CIPC, which lost its approval for use in 2020 and which will no longer be used after the 2019/20 storage season.

It is anticipated that maleic hydrazide will form a mainstay of potato storage sprout suppression in the short term as it is one of very few products (others are ethylene and spearmint oil) currently available for this purpose.

MH differs from other products in that is applied to the crop in the field and is reliant on good uptake of the chemical through the foliage and its translocation to the tubers for it to be effective.

Its use as a potato sprout suppressant has been reviewed as part of this project and that review has been published separately by AHDB (Cunnington, 2019).

Specifically, the main trial reported here, conducted in Year 1 of the work, looked at the effectiveness of sprout suppression by maleic hydrazide applied to two crops of potatoes (one at AHDB Strategic Potato (SPot) Farm North and another at AHDB SPot Farm West). Produce from these field treatments was stored at Sutton Bridge Crop Storage Research (SBCSR).

2 Material and methods

.

Trial crops were treated by sub-contractors at two AHDB strategic farm sites:

1. SPot North: RJ & AE Godfrey, Somerby Top Farm, Somerby Wold Lane, Barnetby, Brigg, DN38 6BN

   At Site 1, one crop of cv Royal was treated with maleic hydrazide

Application details are provided at Appendix 1.

2. SPot West: Heal Farms, Butlers Bank, Shawbury, Shrewsbury, SY4 4HG

   At Site 2, one crop of cv Lady Rosetta was treated with maleic hydrazide

   MH treatments were applied across a range of dates, with and without adjuvant (Appendix 2):

Date of application	No adjuvant	Adjuvant added
3 July 2018	Plot 5	Plot 6
11 July 2018	Plot 1	Plot 2
18 July 2018	Plot 7	Plot 8
25 July 2018	Plot 9	Plot 10
1 August 2018	Plot 3	Plot 4

   An untreated control was taken from adjacent guard plots.

Harvested trials from both sites were shipped to Sutton Bridge CSR for storage in controlled environment stores.

Crops were sub-divided into size bands (40-50, 50-60 and 60-70mm) and sub-samples of each size band were taken for maleic hydrazide residue assessment.

The treated crops were held in store at 9°C/94% RH and assessed for dormancy/sprouting at approximately weekly intervals over a period of up to 200 days. A 3mm sprouting threshold was used to denote break of dormancy. Ordinarily, dormancy break is taken as the point at which 50% of the tubers have exceeded the threshold.

3 Results

Residue results for the two sites (SPot North: Royal and SPot West: Lady Rosetta) are summarised below:

Variety	Plot	Size	Sample #	Result	mean	sd
Royal	1	40-50	S1059-Spot/001	9.1		
Royal		50-60	S1059-Spot/002	14		
Royal		60-70	S1059-Spot/003	14	12.4	2.83
Royal	2	40-50	S1059-Spot/004	11		
Royal		50-60	S1059-Spot/005	14		
Royal		60-70	S1059-Spot/006	18	14.3	3.51
Royal	3	40-50	S1059-Spot/007	9.5		
Royal		50-60	S1059-Spot/008	14		
Royal		60-70	S1059-Spot/009	15	12.8	2.93
Royal	4	40-50	S1059-Spot/010	12		
Royal		50-60	S1059-Spot/011	11		
Royal		60-70	S1059-Spot/012	16	13.0	2.65
Royal	5	40-50	S1059-Spot/013	9		
Royal		50-60	S1059-Spot/014	12		
Royal		60-70	S1059-Spot/015	11	10.7	1.53
Royal	Untreated	40-50	S1059-Spot/016	2.1		
Royal		50-60	S1059-Spot/017	<0.5		
Royal		60-70	S1059-Spot/018	<0.5	0.7	-

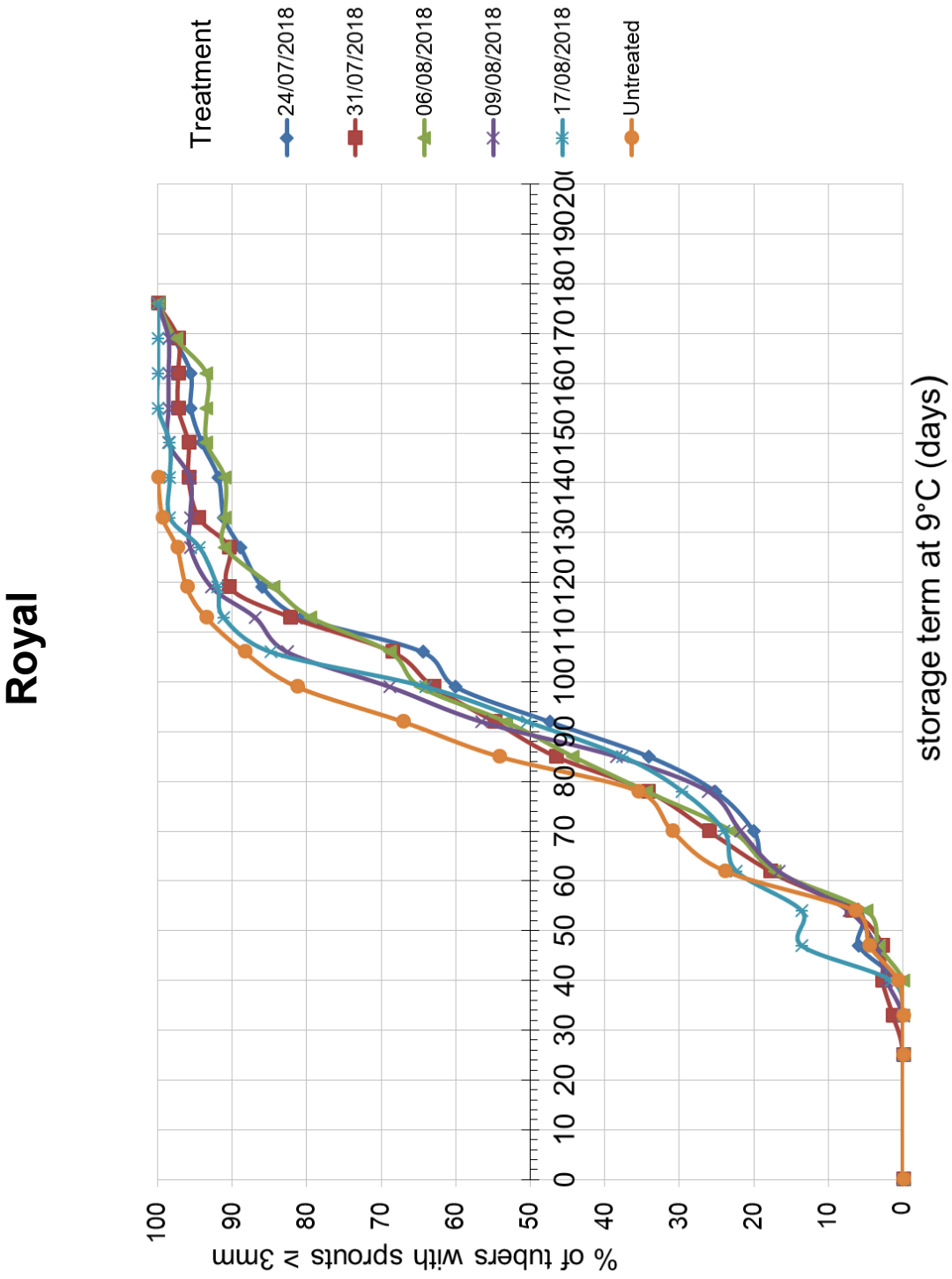
Royal		
MH residue by size band		
	mean	
(mm)	ppm	sd
40-50	10.1	1.32
50-60	13.0	1.41
60-70	14.8	2.59

Variety	Plot	Size	Treatment	Sample #	Result	mean	sd
Lady Rosetta	Plot 1	30-40	MH	S1059-Spot/019	8.3		
Lady Rosetta		40-50	MH	S1059-Spot/020	11		
Lady Rosetta		50-60	MH	S1059-Spot/021	11	10.1	1.56
Lady Rosetta	Plot 2	30-40	MH & Oil	S1059-Spot/022	11		
Lady Rosetta		40-50	MH & Oil	S1059-Spot/023	15		
Lady Rosetta		50-60	MH & Oil	S1059-Spot/024	10		
Lady Rosetta		60-70	MH & Oil	S1059-Spot/025	12	12.0	2.16
Lady Rosetta	Plot 3	30-40	MH	S1059-Spot/026	8.1		
Lady Rosetta		40-50	MH	S1059-Spot/027	9.9		
Lady Rosetta		50-60	MH	S1059-Spot/028	8.5		
Lady Rosetta		60-70	MH	S1059-Spot/029	8.7	8.8	0.77
Lady Rosetta	Plot 4	30-40	MH & Oil	S1059-Spot/030	8.9		
Lady Rosetta		40-50	MH & Oil	S1059-Spot/031	12		
Lady Rosetta		50-60	MH & Oil	S1059-Spot/032	11		
Lady Rosetta		60-70	MH & Oil	S1059-Spot/033	8	10.0	1.84
Lady Rosetta	Plot 5	30-40	MH	S1059-Spot/034	26		
Lady Rosetta		40-50	MH	S1059-Spot/035	28		
Lady Rosetta		50-60	MH	S1059-Spot/036	27		
Lady Rosetta		60-70	MH	S1059-Spot/037	22	25.8	2.63
Lady Rosetta	Plot 6	30-40	MH & Oil	S1059-Spot/038	13		
Lady Rosetta		40-50	MH & Oil	S1059-Spot/039	8.3		
Lady Rosetta		50-60	MH & Oil	S1059-Spot/040	12		
Lady Rosetta		60-70	MH & Oil	S1059-Spot/041	8.8	10.5	2.33
Lady Rosetta	Plot 7	30-40	MH	S1059-Spot/042	16		
Lady Rosetta		40-50	MH	S1059-Spot/043	19		
Lady Rosetta		50-60	MH	S1059-Spot/044	16		
Lady Rosetta		60-70	MH	S1059-Spot/045	17	17.0	1.41
Lady Rosetta	Plot 8	30-40	MH & Oil	S1059-Spot/046	7.4		
Lady Rosetta		40-50	MH & Oil	S1059-Spot/047	15		
Lady Rosetta		50-60	MH & Oil	S1059-Spot/048	13		
Lady Rosetta		60-70	MH & Oil	S1059-Spot/049	19	13.6	4.83
Lady Rosetta	Plot 9	30-40	MH	S1059-Spot/050	8.3		
Lady Rosetta		40-50	MH	S1059-Spot/051	5.8		
Lady Rosetta		50-60	MH	S1059-Spot/052	9.2		
Lady Rosetta		60-70	MH	S1059-Spot/053	9.1	8.1	1.59
Lady Rosetta	Plot 10	30-40	MH & Oil	S1059-Spot/054	11		
Lady Rosetta		40-50	MH & Oil	S1059-Spot/055	9.9		
Lady Rosetta		50-60	MH & Oil	S1059-Spot/056	11		
Lady Rosetta		60-70	MH & Oil	S1059-Spot/057	8.9	10.2	1.01
Lady Rosetta	Untreated	30-40		S1059-Spot/058	<0.5		
Lady Rosetta		40-50		S1059-Spot/059	<0.5		
Lady Rosetta		50-60		S1059-Spot/060	<0.5		
Lady Rosetta		60-70		S1059-Spot/061	<0.5	<0.5	-

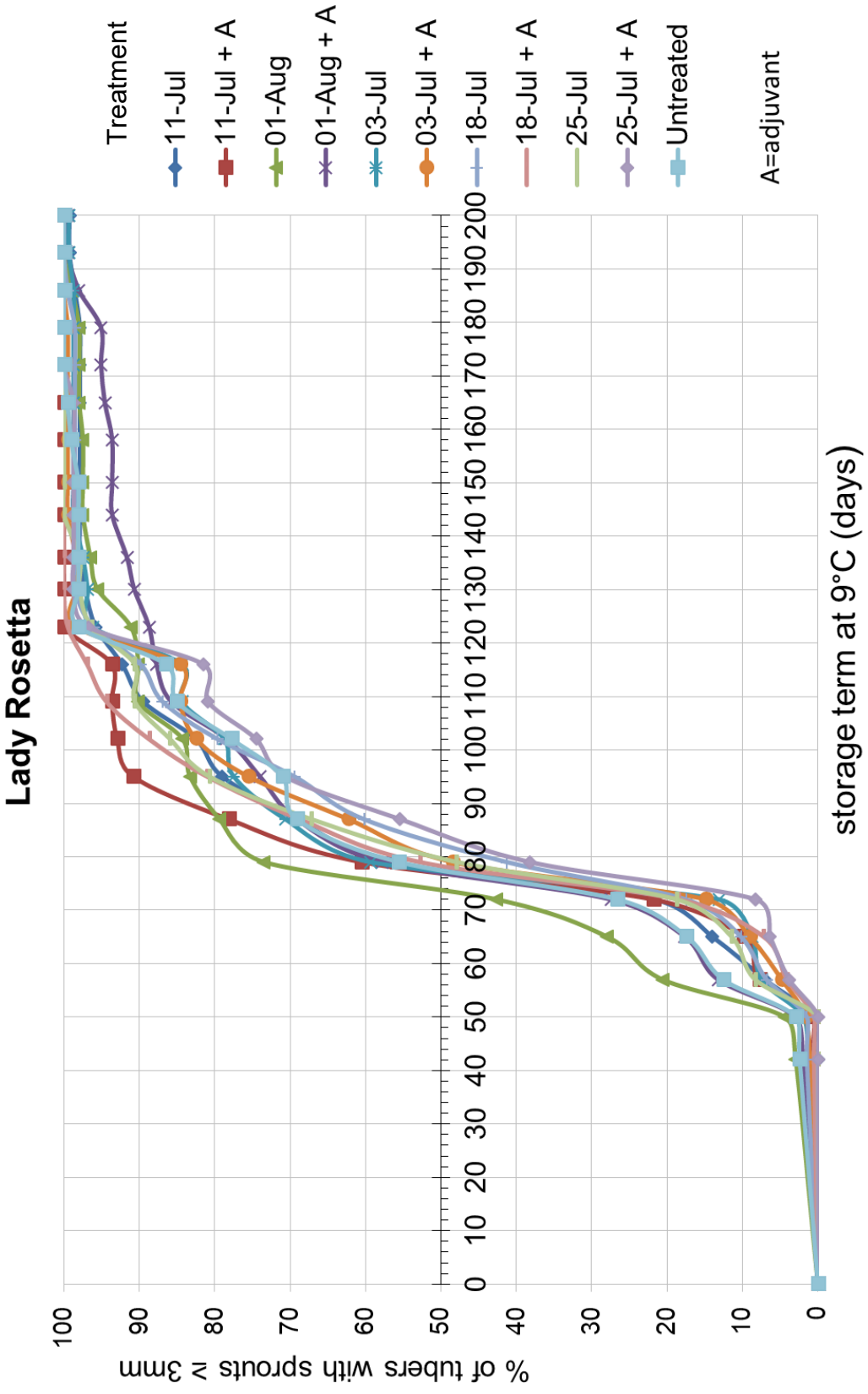
Lady Rosetta		
MH residue by size band		
(mm)	mean ppm	sd
30-40	13.3	7.84
40-50	14.7	8.82
50-60	14.3	7.66
60-70	14.2	6.45

Sprouting assessment results are summarised below:

Site 1: SPot North (cv Royal)



Site 2: SPot West (cv Lady Rosetta)



4 Discussion

At Site 1, there was little difference in the residual level of MH measured in tubers across all five treatment occasions. Means levels were close to the target figure of 12 ppm for effective sprout suppression (Cunnington, 2019) but residues varied markedly between samples, indicating a high degree of variability in uptake.

These similar levels were apparent in the sprout control data with very little difference apparent across the five treatments. There was only a very small difference between the treated crops and the untreated control, suggesting that MH application had resulted in little suppression of sprouting in Royal.

At Site 2, the earliest application of MH (treatment on 3 July) to Lady Rosetta resulted in the highest residual level (≥22 ppm) of the chemical in the tubers, although the pattern was not entirely consistent across subsequent dates. Generally, however, the crop was observed to be increasingly senesced under droughted conditions from T1 to T5.

There was no clear benefit from the addition of mineral oil as an adjuvant at Site 2. On none of the treatment dates did it make a significant difference to the residue of MH measured in the tubers.

In terms of sprout control, MH had only a marginal impact at Site 2, compared with the untreated control, perhaps as a result of the droughted state of the crop in the field. The final application on 01 August was the least effective at suppressing sprouting suggesting that uptake by the crop in its most senesced state was inadequate.

5 Conclusions

It is difficult to draw many conclusions at such an early stage in this trial, especially when the treatments were applied during one of the most droughted periods experienced in potato production for over 40 years..

However, the data do indicate that in the crops assessed, some sprout suppression could be achieved for approximately 50 days or longer (in some instances up to as much as 100 days) from application of maleic hydrazide in the field. This offers potential, in a more favourable year, for residual control of sprouting as the foundation of a multi-faceted sprout suppression regime.

Application and uniformity of uptake need to be optimised to maximise potential of the treatment. If this is achieved, it will reinforce the predictability and robustness of maleic hydrazide use as a sprout suppression treatment.

Although this was the first year of work, the project was included in an AHDB communications article published in summer 2018 (see Appendix 3)

6 References

Cunnington, A.C. (2019) Maleic hydrazide as a potato sprout suppressant. AHDB Review. AHDB, Kenilworth. 21 pp.

Appendix 1: SPot North

T1

Crop at T1

T2

Richard Austin agriculture ltd
Agricultural Consultants & Laboratory Soil Analysis

APPLICATION DETAILS

PROJECT: AHDB Potatoes MH
TRIAL NO: CAA – 22 – 2018
APPN NUMBER: T2

SITE: Somerby
SPRAYED BY: J. Keer
MIXED BY:

DATE: 31/7/18
TIME: 0930 – 1000
CROP GS:
CROP COVER: 100% GC
TIME TILL RAIN: 2 days+ (forecast)

AIR TEMP (°C): 17
SOIL TEMP(°C): 16
WIND SPEED (Kph): 5
RH (%):
CLOUD COVER(%): 10
WIND DIRECTION: SW

WEATHER AT APPLICATION:	(SUNNY)	OVERCAST	WET	HUMID
LEAF MOISTURE:	(DRY)	DAMP	WET	
SOIL surface MOISTURE :	DRY	DAMP	(MOIST)	WET
SOIL sub-surface MOISTURE	DRY	DAMP	(MOIST)	WET
SOIL CONDITIONS:	FIRM	(LOOSE)	CAPPED	
TILTH OF SOIL:	LARGE CLODS	MEDIUM CLODS	SMALL CLODS	(FINE)

APPLICATOR TYPE: Pulvaxpur 3m
PRESSURE: 3·2bar
VOLUME: 400l/ha

NOZZLES: 05 LD
SPEED: 0·5m/s
SPRAY QUALITY: medium

TREATMENTS (Timing, Treatment nos., and protocol date and issue)

T2 TH 2

WEEDS/DISEASES

COMMENTS Recent rain photos.
10% foliage yellow, 2% necrotic (brown) Haulm good larger with nice blue/green colour. Crop stress-free.

SIGNATURE:

Form 10/1

T3

Richard Austin agriculture ltd
Agricultural Consultants & Laboratory Soil Analysis

APPLICATION DETAILS

PROJECT: AHDB Potatoes MH
TRIAL NO: PAA-22-2018
APPN NUMBER: T3

SITE: Somerby
SPRAYED BY: J. Keer
MIXED BY:

DATE: 6/8/18
TIME: 1220-1300
CROP GS: 100% GC
CROP COVER:
TIME TILL RAIN: 1 day+

AIR TEMP (°C): 27
SOIL TEMP(°C): 20
WIND SPEED (Kph): 6
RH (%):
CLOUD COVER(%): 20
WIND DIRECTION: W

WEATHER AT APPLICATION:	(SUNNY)	OVERCAST	WET	HUMID
LEAF MOISTURE:	(DRY)	DAMP	WET	
SOIL surface MOISTURE :	(DRY)	DAMP	MOIST	WET
SOIL sub-surface MOISTURE	DRY	(DAMP)	MOIST	WET
SOIL CONDITIONS:	FIRM	(LOOSE)	CAPPED	
TILTH OF SOIL:	LARGE CLODS	MEDIUM CLODS	SMALL CLODS	(FINE)

APPLICATOR TYPE: Pulverpur 3m
PRESSURE: 3.2 bar
VOLUME: 400L

NOZZLES: 015LD
SPEED: 0.5m/s
SPRAY QUALITY: medium

TREATMENTS (Timing, Treatment nos., and protocol date and issue)

T3 Trt 2

WEEDS/DISEASES Photos.
Crop moderately stressed. Foliage dark green. No further leaves senescing but pale green leaves at T1/T2 now mostly necrotic. 10% necrotic and 2% haulm pale green/yellow. Soil would just fail "Smear test".

COMMENTS

SIGNATURE:

T4

Richard Austin agriculture ltd
Agricultural Consultants & Laboratory Soil Analysis

APPLICATION DETAILS

PROJECT: AHDB Potatoes MH
TRIAL NO: RAA – 22–2018
APPN NUMBER: T4

SITE: Somerby
SPRAYED BY: J. Keer
MIXED BY:

DATE: 9/8/18
TIME: 1500–1530
CROP GS: See below
CROP COVER: 100%GC
TIME TILL RAIN: 24hrs (forecast)

AIR TEMP (°C): 18
SOIL TEMP(°C): 18
WIND SPEED (Kph): 2
RH (%):
CLOUD COVER(%): 100%
WIND DIRECTION: E

WEATHER AT APPLICATION:	SUNNY	(OVERCAST)	WET	HUMID
LEAF MOISTURE:	(DRY)	DAMP	WET	
SOIL surface MOISTURE :	(DRY)	DAMP	MOIST	WET
SOIL sub-surface MOISTURE	DRY	(DAMP)	MOIST	WET
SOIL CONDITIONS:	FIRM	(LOOSE)	CAPPED	
TILTH OF SOIL:	LARGE CLODS	MEDIUM CLODS	SMALL CLODS	(FINE)

APPLICATOR TYPE: Pulverisper 3m
PRESSURE: 3.2bar
VOLUME: 400l/ha

NOZZLES: 05CD
SPEED: 0.5m/s
SPRAY QUALITY: medium

TREATMENTS (Timing, Treatment nos., and protocol date and issue)

T4, TTs. 2

WEEDS/DISEASES
Crop turgid. Soil would marginally pass "Smart test". Haulm still green. Senescence of bottom leaves only. 10% necrotic and 5% pale green/yellow. Crop moderately stressed. Photos ×3. Transpirational stress lower than of late.

COMMENTS
forecast dry 24hrs

SIGNATURE:

T5

Richard Austin agriculture ltd
Agricultural Consultants & Laboratory Soil Analysis

APPLICATION DETAILS

PROJECT: AHDB Potts – MH
TRIAL NO: RAA-22-2018
APPN NUMBER: T5

SITE: Somerby
SPRAYED BY:) J. Keer
MIXED BY:

DATE: 17/8/2018
TIME: 1630–1715
CROP GS: see below
CROP COVER:
TIME TILL RAIN: 1 day+

AIR TEMP (°C): 18
SOIL TEMP(°C): 16
WIND SPEED (Kph): 7
RH (%):
CLOUD COVER(%): 100
WIND DIRECTION: W

WEATHER AT APPLICATION:	SUNNY	(OVERCAST)	WET	HUMID
LEAF MOISTURE:	(DRY)	DAMP	WET	
SOIL surface MOISTURE :	(DRY)	DAMP	MOIST	WET
SOIL sub-surface MOISTURE	DRY	DAMP	(MOIST)	WET
SOIL CONDITIONS:	FIRM	(LOOSE)	CAPPED	
TILTH OF SOIL:	LARGE CLODS	MEDIUM CLODS	SMALL CLODS	(FINE)

APPLICATOR TYPE: Pulverper 3m
PRESSURE: 3·2bar
VOLUME: 400l/ha

NOZZLES: 075LD
SPEED: 0·5m/s
SPRAY QUALITY: medium

TREATMENTS (Timing, Treatment nos., and protocol date and issue)

T5, TH 2.

WEEDS/DISEASES

Crop turgid. Soil passes "smear test". Haulm still predominantly green. Senescence of bottom 1/3rd canopy 15% necrotic leaf + 10% pale green.
Photos x4 (one general pic of trial)

COMMENTS

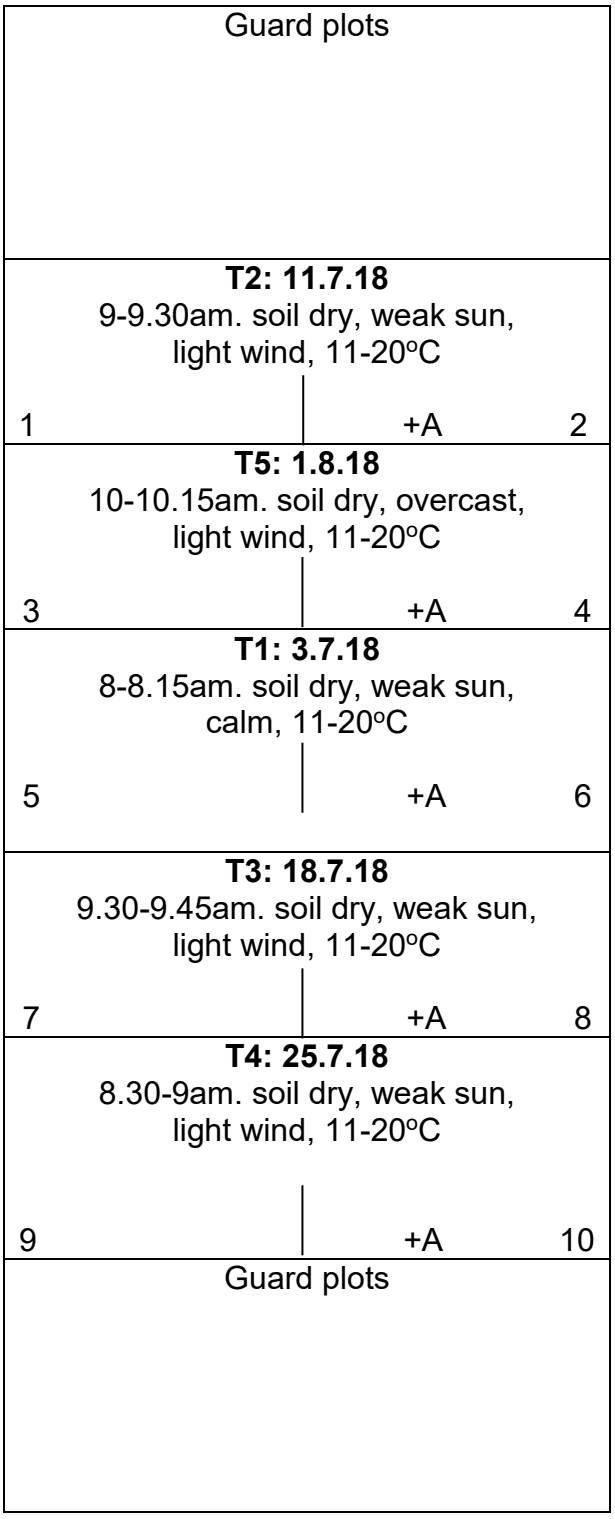
SIGNATURE:

Form 10/1

Appendix 2: SPot West

Maleic hydrazide, Heal Farms 2018

MH applications. All at 2 bar, 400l/ha water. Nozzles flat fan F110-003.
Each treatment made half with and half without mineral oil adjuvant (A).



Lodge House and hardstanding end

Appendix 3: AHDB article including maleic hydrazide

Timing of maleic hydrazide applications, formulating best practice for incorporating nematicide, seeking best-use of the new nematicide fluopyram and biofumigation are the topics for this year's SPot Farm West, Heal Farms. Heather Briggs attended the Farm Walk at the end of July to find out more about this year's work.

One of the challenges with working on a large commercial farm is time management, so many field treatments are standardised across the different fields, said independent agronomist Denis Buckley of Highfield Lodge Agronomy.

He opened the day by giving data about the SPot Farm which is in its second year (see panel), noting that this year Linuron forms part of the herbicide strategy for the last time as it is in its use-up period.

Update on sprout suppressants

Sprout suppressant CIPC is undergoing re-registration but has not yet completed its review, reported Adrian Briddon of Sutton Bridge Crop Storage Research (SBCSR).

This means that as yet no-one knows if modifications to the conditions of use will be required, he said.

To be prepared for whatever results finally emerge, alternative suppressants to chlorpropham (CIPC) are being explored, including maleic hydrazide, ethylene, spearmint oil, DMN, CIPC on its own and with other treatments. At the SPot Farm West we have a particular interest in maleic hydrazide

Maleic hydrazide, which stops cell division, is used for a number of purposes; in the field it is best known for controlling volunteers, but it is also a sprout suppressant and, although off-label, is also used to control secondary growth.

Often used for processing potatoes, however, more supermarkets and packers are accepting it on varieties troubled by short dormancy such as King Edward, revealed Mr Briddon.

"Different varieties have different dormancy lengths but store managers rarely get to put one variety per store. .

"As a result, if one variety breaks dormancy, the whole store has to be treated;. However, maleic hydrazide could provide a better way of controlling sprouting while keeping these short dormancy varieties together with those which have longer dormancy because only those needing treatment are treated." This is a good step towards integrated control of sprouting.

Mr Briddon said: "It can give long periods of sprout control, and application in the field could even be considered as a pre-treatment for CIPC or other treatments. However, conditions need to be right at the time of application, and sometimes that is very difficult."

Application of the active should be done to actively growing crop when the smallest tubers are at an appropriate size, according to label recommendations. This is normally three to five weeks before haulm destruction, said Mr Briddon.

"If it is applied to stressed crops, such as during a drought, uptake can be compromised," he warned.

Moreover, early morning or evening applications are advisable during times of high temperatures, he said.

At this year's SPot Farm West there will be plots of Lady Rosetta treated with maleic hydrazide which will go into storage.

Treatments with and without a mineral oil adjuvant will also be assessed. While approval-holder Arysta states that mineral oil adjuvants can inhibit uptake, some agronomists recommend them, as they believe they improve uptake, especially if rain is forecast within 24 hours.

To illustrate the importance of timing, plots have been set up with the following application timings on Lady Rosetta, with and without mineral oil: July 3, July 11, July 18, July 25 and August 1.

SPot Farm host Matthew Wallace had been planning to use Fazor (maleic hydrazide) this year to help control volunteers and improve storage. However, he decided not to use it because he believes the cost is not justified in a low-yielding year like 2018. Moreover, he feels that due to the short season, three to five weeks before desiccation there will be insufficient time when the tubers are the optimum size.

This may result in insufficient uptake of the active, so it could be wasted.

Because of the heat and drought, Mr Wallace also felt that application would add another layer of stress to an already stressed crop.

Sprout suppressant trials

Store managers should not be dependent on just one chemical in the future, insisted Mr Briddon, adding that they may benefit from alternating CIPC with other suppressants to control sprout growth.

Both ethylene and spearmint oil now feature in national statistics for pesticide usage carried out by FERA, which means they are established in the potato storage industry.

Alternatives currently approved include maleic hydrazide, ethylene, and spearmint oil; with the latter two having the benefit of not being subject to an MRL, he said.

"We know that ethylene can work well for fresh-pack potatoes and at SBCSR we have been looking at its potential for processing potatoes. Our results show differences between varieties, but with certain ones it can be an option as it has proved to have satisfactory efficacy without compromising processing quality."

However, given challenges with fry colours, particularly for crisps, few store managers will opt to use it while CIPC is still available, he said.

Spearmint oil is already used, frequently as a top-up for CIPC during long term storage if dormancy breaks, noted Mr Briddon. The problem is that it is also more costly, he said.

Orange oil may prove to be a useful sprout suppressant in the future, and already has Annex I approval, reveals Adrian. It is currently being developed by Arysta Lifesciences, and it may be available as soon as 2019.

"We are awaiting results of efficacy trials held at SBCSR on orange oil," he said, and of course, CRD's approval.

Despite registrations in other European countries, DMN (1,4-dimethylnaphthalene) is still awaiting approval in the UK.

3-decen-2-one, marketed as SmartBlock, is in a similar position awaiting registration, but may be available by 2020, he added.

Nematicide incorporation

PCN control was poor when Heal Farms incorporated nematicide with a rotary tiller on front of the planter, so the farm's practice is to apply it using a bed-tiller mixing to 30cm,before de-stoning said Dr Anne Stone, knowledge exchange manager at AHDB Potatoes.

Good sampling techniques are the first step to PCN management, independent agronomist Martyn Cox of Blackthorn Arable told delegates.

Not only do populations occur in hot-spots but the distribution varies between old populations which typically have been spread over a wide area, populations growing fast on the edge of a patch and declining at very high densities. Younger, freshly developing population are more patchy as they have been spread less he said.

Additionally, soil densities can vary, 100 g of soil is tested but the volume in that sample varies from 200cc on a peat but it can be just 80cc in sand.

"If you suspect you have PCN, you may be missing out on yield and profitability, so you need to build a picture which is as accurate as possible.

"Testing at one sample of (50 cores) per 4ha sample will give you an average or miss patches altogether.

"The same number of cores per two hectares may suffice if you know your land but 'hot spots' need to be further investigated and detection will still be poor," he said.

Mr Cox noted that 50 cores per hectare is the best commercial standard but still leaves a lot to desire in terms of finding low populations.

"You may want to thoroughly sample a small area inside the field entrance as this is where they would be expected to arrive.

"All PCN sampling really needs to be done using GPS, the cost is minimal when you think of the investment in the crop. It is also a multi-year issue, so any savings may look futile in a few years when you go back to that field.

"Getting a drone flight over a potato crop can really pay dividends too".

Moreover, PCN damage is integrated with other pests and diseases, he added, noting that Verticillium Wilt is known to be antagonised by nematodes, including lesion nematode and PCN.

Dr Stone noted that Rhizoctonia (R. solani) can slow emergence, and while that is happening the PCN are feeding away at the roots. This demonstrates the importance of treating for rhizoctonia even when the seed 'appears clean'; moreover, AHDB research has shown that tubers declared clean after visual inspection can frequently be found to be infected by DNA testing.

Other problems occur as a result of poor root growth and uptake of nutrients. Tissue testing of PCN-damaged plants this year has shown around 20-30 per cent less N, P, K and Mg compared with nearby plants, observed Dr Stone.

Foliar feeding a crop with the first blight sprays can help the plant grow away from attack, N, P and K all need to be applied.

Other factors are seed size, planting time and soil type.

Using larger seed is a good policy in the areas where PCN is higher, and delayed application of contact herbicide should be avoided, she added, noting that high pH soils tend to suffer more phosphate uptake, as do soils high in Iron.

She went on to say that nematicide incorporation is normally done around 15cm deep but it is advisable to avoid going any shallower than that.

Mr Cox also quoted research work done in the 1980s, which states that PCN are evenly distributed in the top 40 cm of the ridge but less are found below this level. This tends to be plough depth.

Vertical incorporation of nematicides is essential, he emphasised, as doing it horizontally so it is shallow does not work, and when the Roterra type of machine was used for incorporation alone, control was poor.

Getting the best performance from the nematicide is key, so to help develop best practice there are a number of treatments being explored on the farm, Dr Stone announced.

New nematicide trial

The new Bayer SDHI nematicide, based on the active substance Fluopyram, has received a special consumer permit to allow trials on a limited area of potatoes destined for market, revealed Bayer Field Marketing Specialist Miles Taylor. Bayer is hoping to receive approval for the nematicide to be used on the 2019 commercial crop.

The active has a good environmental profile and activity on a broad spectrum of nematodes such as PCN and free living nematodes, along with the practical benefits of being a low dose liquid formulation, he said.

However, he noted, while it will often be used alone for PCN control, it is also likely to be used in conjunction with another nematicide. This could allow lower rates of other products to be applied. The product can be applied either in-furrow or as an overall spray using a conventional farm sprayer with similar performance meaning the preferred means of application is whatever is most convenient for the user.

The ease of application, which at 625ml/ha is likely to represent a significant time-saving to the operator, is also expected to extend PCN control to low-pressure situations when the grower may otherwise consider populations too low to warrant using a nematicide.

It is also unlikely to have a restrictive harvest interval, suggested Mr Taylor.

The new nematicide will also not suffer from the same difficulties regarding its position in the soil profile as it can be applied at planting and has sufficient persistence in the soil to not be washed away, delegates were told. The trial will be harvested later this season and soil cores taken at GPS-marked sites to give meaningful results and support pf/pi calculations to assess its contribution to reducing multiplication rates.

Mr Taylor also described a new herbicide based on the active 'aclonifen' which offers safe, broad spectrum and robust weed control which should be very useful to growers concerned about the loss of linuron. The product is aiming to be launched for use in the 2019 season.

Treatments:

- Full rate Nemathorin
- Half rate Nemathorin + fluopyram in-furrow + Amistar
- Half rate Nemathorin + fluopyram overall spray + Amistar
- Half rate Nemathorin + fluopyram in-furrow + Monceren
- Half rate Nemathorin + fluopyram in-furrow
- Full rate Nemathorin + fluopyram in furrow + Amistar

Sprout suppressant trials

Store managers should not be dependent on just one chemical in the future, insisted Mr Briddon, adding that they may benefit from alternating CIPC with other suppressants to control sprout growth.

Both ethylene and spearmint oil now feature in national statistics for pesticide usage carried out by FERA, which means they are established in the potato storage industry.

Alternatives currently approved include maleic hydrazide, ethylene, and spearmint oil; with the latter two having the benefit of not being subject to an MRL, he said.

"We know that ethylene can work well for fresh-pack potatoes and at SBCSR we have been looking at its potential for processing potatoes. Our results show differences between varieties, but with certain ones it can be an option as it has proved to have satisfactory efficacy without compromising processing quality."

However, given challenges with fry colours, particularly for crisps, few store managers will opt to use it while CIPC is still available, he said.

Spearmint oil is already used, frequently as a top-up for CIPC during long term storage if dormancy breaks, noted Mr Briddon. The problem is that it is also more costly, he said.

Orange oil may prove to be a useful sprout suppressant in the future, and already has Annex I approval, reveals Adrian. It is currently being developed by Arysta Lifesciences, and it may be available as soon as 2019.

"We are awaiting results of efficacy trials held at SBCSR on orange oil," he said, and of course, CRD's approval.

Despite registrations in other European countries, DMN (1,4-dimethylnaphthalene) is still awaiting approval in the UK.

3-decen-2-one, marketed as SmartBlock, is in a similar position awaiting registration, but may be available by the early 2020s, he added.