SCEPTREPLUS

Final Trial Report

Trial code:	SP47a
Title:	**Powdery Mildew Control in Protected Crops (Cucumber)**
Crop:	Cucumber but also potentially applicable to all other protected crops
Target:	Powdery Mildew (caused by *Podosphaera xanthii, Erysiphe cichoracearum* and others)
Lead researcher:	Kirsty Wright
Organisation:	Stockbridge Technology Centre
Period:	July – October 2019
Report date:	3rd December 2019
Report author:	Kirsty Wright
ORETO Number: (certificate should be attached)	372

I the undersigned, hereby declare that the work was performed according to the procedures herein described and that this report is an accurate and faithful record of the results obtained.

…… ……

Date Authors signature

Trial Summary

Introduction

Powdery Mildew continues to be a priority target in many crops. A model crop approach was suggested for this work but the specific needs of the different protected crop sectors made this unfeasible. This trial was designed to identify new 'knockdown' products for use in cucumber crops, but would also be applicable to other crops where a certain level of powdery mildew can be tolerated before treatment application is necessary. Until recently cucumber growers have been able to use Nimrod (bupirimate) to control powdery mildew but its use has now been limited. Alternative products need to be identified to fill the gap left by this new limited approval.

Methods

A semi-tolerant variety of cucumber (Lucania), treated immediately after planting with Takumi (cyflufenamid), was used to enable crop establishment without early infection. The crop was planted in early August to equate to the third commercial planting of the year and to coincide with optimal conditions for disease in late summer/autumn. Once the crop was well-established, inoculum was introduced to the crop and allowed to develop for approximately two weeks. At this point there was a moderate level of infection in the crop. Four conventional products were then applied once whilst two biopesticide products were applied twice at 7 day intervals.

Results

A summary of the trial result is shown below, presented as percent disease control by each treatment, relative to the Untreated (water only) control.

		% Disease control relative to T1 (untreated)			
Trt	**AHDB Code**	**9.9.19**	**18.9.19**	**24.9.19**	**7.10.19**
1	Untreated (water only)				
2	Nimrod	49.551	11.323	0.1	0
3	AHDB9862	48.654	59.619	63.1	19.3
4[a]	Untreated	8.079	0.6012	0.1	0
5	AHDB9834	50.628	64.93	78.3	36
6	AHDB9835	67.504	81.363	85.3	37.1
7	AHDB9833	57.989	65.431	57.9	19.7
8	AHDB9830	29.443	1.503	0.2	0
	Not significantly different from untreated control (p>0.05)				
	Significantly different from untreated control (p<0.05)				

[a] Note that the product identified for Treatment 4 was never received so this treatment is effectively another untreated control.

Conclusions

All products gave some level of control of cucumber powdery mildew. Treatment 2, the standard product Nimrod (bupimrimate) did not achieve either high levels of control, or prolonged control. This highlights the need for additional products to be found and approvals sought. AHDB9862, AHDB9834 and AHDB9835 are all conventional chemistry and provided good levels of control- in the case of AHDB9834 and AHDB9835 an 80% reduction of disease was achieved 3 weeks after treatment application. AHDB9833 (a biopesticide) gave interesting results too, with a

65% reduction in disease after 2 applications of product and some efficacy still evident two weeks after the last application of product.

Take home message

Powdery mildew control was achieved by a number of products in the trial, with a significant reduction in disease levels still evident in some treatments over a month after treatment application. There is significant promise of some of these products being approved for use on protected cucumber in the UK as approvals already exist in other regions or on other crops in the UK.

Objectives

To assess a selection of conventional fungicides and biopesticides for crop safety and for activity against powdery mildew in cucumber, caused mainly by *Podosphaera xanthii* and *Erysiphe cichoracearum*.

Trial conduct

UK regulatory guidelines were followed but EPPO guidelines took precedence. The following EPPO guidelines were followed:

Relevant EPPO guideline(s)		**Variation from EPPO**
PP 1/152(3)	Design and analysis of efficacy evaluation trials	None
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None
PP 1/57 (3)	Powdery mildew on cucurbits and other vegetables	None

There were no deviations from EPPO guidance.

Test site

Item	**Details**
Location address	Glasshouse M19, Stockbridge Technology Centre Cawood Selby YO8 3TZ
Crop	Cucumber
Cultivar	Lucania
Soil or substrate type	Rockwool
Agronomic practice	The crop was planted onto rockwool slabs and immediately sprayed with an application of Takumi to prevent powdery mildew establishing too quickly. No further applications of fungicides were applied apart from the test treatments. No insecticides were applied to the crop. Biocontrol products were used as necessary.
Prior history of site	No prior crops in 2019.

Trial design

Item	**Details**
Trial design:	Incomplete Trojan Square Row/Column design
Number of replicates:	6
Row spacing:	1.2m
Plot size: (w x l)	2.4 x 1.67m
Plot size: (m^2)	$4m^2$
Number of plants per plot:	8

Treatment details

AHDB Code	Active substance	Product name/ manufacturers code	Formulation batch number	Content of active substance in product	Formulation type
Untreated (water only)	-	-	-	-	-
Nimrod	Bupirimate	Nimrod	981101117	250 g/l (27.2% w/w)	EC
AHDB9862	ND	NA	ND	ND	ND
Untreated	-	-	-	-	-
AHDB9834	ND	NA	ND	ND	ND
AHDB9835	ND	NA	ND	ND	ND
AHDB9833	ND	NA	ND	ND	ND
AHDB9830	ND	NA	ND	ND	ND

Application schedule

Treatment number	Treatment: product name or AHDB code	Rate of active substance (ml or g a.s./ha)	Rate of product (l or kg/ha)	Application code
1	Untreated (water only)	-	-	AB
2	Nimrod	375 g a.s./ha	1.5 l/ha	A
3	AHDB9862	112.5 g a.s./ha	1.5 l/ha	A
4	Untreated	-	-	
5	AHDB9834	125 g a.s./ha	1.0 l/ha	A
6	AHDB9835	100 g a.s./ha	1.0 l/ha	A
7	AHDB9833	320 g a.s./ha	0.6%	AB
8	AHDB9830	660 ml a.s./ha	4 l/ha	AB

Application details

	Application A	Application B
Application date	04.09.19	11.09.19
Time of day	14:00-18:00	12:30-13:30
Crop growth stage (average BBCH)	73	74
Crop height (cm)	350	350
Crop coverage (%)	75	75
Application Method	Spray	Spray
Application Placement	Foliage	Foliage
Application equipment	OPS	OPS
Nozzle pressure	2 bar	2 bar
Nozzle type	Flat Fan	Flat Fan
Nozzle size	01 F80	01 F80
Application water volume/ha	888	888
Temperature of air - shade (°C)	22.1	24.6
Relative humidity (%)	80.0	79.5
Wind speed range (m/s)	n/a	n/a
Dew presence (Y/N)	N	N
Temperature of soil - 2-5 cm (°C)	n/a	n/a
Wetness of soil - 2-5 cm	n/a	n/a
Cloud cover (%)	n/a	n/a

Untreated levels of pests/pathogens at application and through the assessment period

Common name	Scientific Name	EPPO Code	Infestation level pre-application	Infestation level at start of assessment period	Infestation level at end of assessment period
Powdery Mildew	*Podosphaera xanthii* and others	PODOXA	29.1[a]	55.7[a]	100.0[a]

[a] Disease levels assessed using a 0-5 scale and then converted to a disease index (0-100)

Assessment details

	Evaluation Timing (DA)*				
Evaluation date	**After conventional fungicides**	**After Bio-fungicides**	**Crop Growth Stage (BBCH)**	**Evaluation type (efficacy, phytotox)**	**Assessment**
04.09.19	Before	Before	73	Pre-application disease levels	0-5
09.09.19	5	5	73	Efficacy/Phytotox	0-5
18.09.19	14	7	74	Efficacy/Phytotox	0-5
24.09.19	20	13	75	Efficacy/Phytotox	0-5
07.10.19	33	26	76	Efficacy/Phytotox	% leaf area

* DA – days after application

A baseline assessment was carried out immediately before the first application of products. This was done on 3 tagged leaves (upper, middle and lower) on each of 4 plants per plot, using a 0-5 scale where:

0 = no powdery mildew pustules present
1 = < 5 powdery mildew pustules
2 = 5-30 powdery mildew pustules
3 = 30-50 powdery mildew pustules
4 = 50-100 powdery mildew pustules
5 = > 100 powdery mildew pustules

5, 14 and 20 days after the first application of products a second disease severity assessment was carried out on the tagged leaves, using the same scale as above. Just over one month after the first application of products a final assessment of percent leaf area affected per plant was carried out on each of four plants per plot.

Statistical analysis

Data were analysed by analysis of variance (ANOVA) using terms for rows, columns, squares and the two pseudofactors (treatments occur, at most, once in a pair of plots either side of the fleece barrier between rows; and each of the 8 treatments occurred at least once in each of the complete rows of 12 plots), as specified by Andrew Mead. Whilst the main focus was on comparisons between treatments and control, a multiple comparison procedure was used to permit other treatment comparisons. Sidak's method was used, as most of the more common approaches cannot be used with this type of complex design. Residuals from the analysis of variance were checked graphically for non-normality, heteroscedasticity, and spatial correlation, with transformations applied where necessary to meet the assumptions of the analysis. All analyses were carried out in Genstat (20th Edition).

Disease severity on a 0-5 scale was converted to a disease index (0-100) and averaged over the four plants. An angular transformation was applied to data on a 0-100 scale. Where all leaves in a layer senesced over time a missing value was used and, in the case of the bottom layer at the final time, there were too many missing values to permit a reliable significance test. An average value over the three layers was also analysed and for this purpose the missing values were imputed (i.e. replaced by estimated values) to avoid biasing the average for those plots where one or more layers was missing.

Results

Phytotoxicity

No conclusive evidence of phytotoxicity was observed during the course of the trial. There was however some suggestion that Treatment 5 may have caused some paling at the leaf margins on some plants. This was seen mainly in one plot and was not statistically analysed. See Figure 1.

Figure 1: Evidence of some phytotoxicity caused by Treatment 5 (AHDB9834) 21 DAT.

Efficacy

All efficacy data is presented in Table 1 and a summary of data from each significant assessment timing is shown in Figures 2, 3, 4 and 5 below.

Table 1: means for each treatment for each variable and test statistics for treatment differences from analysis of variance. F tests have 7 and 29 d.f., except where missing values were present. Shaded means are significantly different to the control

				Treatment mean							
variable	**Date**	**F**	**P**	**T1 (unt)**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
Upper	4.9.19	0.92	0.507	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0
Middle	4.9.19	0.38	0.908	18.5	16.4	14.2	21.4	12.0	12.7	13.5	14.0
Lower	4.9.19	0.41	0.888	69.9	62.8	72.8	70.5	64.5	67.1	64.2	69.7
All	4.9.19	0.36	0.918	29.1	26.0	28.5	30.6	26.3	26.1	26.7	28.3
Upper	9.9.19	15.28	<0.001	41.3	8.2	7.1	36.1	5.0	1.5	7.8	22.9
Middle	9.9.19	12.44	<0.001	47.4	24.7	22.9	42.5	25.0	7.8	20.3	31.4
Lower	9.9.19	5.85	<0.001	82.1	48.3	55.5	76.6	50.2	42.9	39.5	63.2
All	9.9.19	18.10	<0.001	55.7	28.1	28.6	51.2	27.5	18.1	23.4	39.3
Upper	18.9.19	93.23	<0.001	100.0	90.4	28.8	99.2	16.1	6.5	24.0	99.0
Middle	18.9.19	28.66	<0.001	99.8	85.8	28.0	99.7	28.9	5.5	26.8	97.2
Lower	18.9.19	23.78	<0.001	92.8	98.0	54.1	99.9	65.9	30.4	41.4	94.8
All	18.9.19	81.42	<0.001	99.8	88.5	40.3	99.2	35.0	18.6	34.5	98.3
Upper	24.9.19	95.95	<0.001	100.0	99.8	25.2	99.7	10.4	9.7	36.0	99.7
Middle	24.9.19	76.30	<0.001	100.0	99.7	30.9	99.8	16.8	4.8	35.1	100.0
Lower	24.9.19	Insufficient data		91.4	86.4	66.5	100.0	62.0	11.3	57.9	91.0
All	24.9.19	146.47	<0.001	100.0	99.9	36.9	99.9	21.7	14.7	42.1	99.8
%leaf	7.10.19	9.73	<0.001	100.0	100.0	80.7	100.0	64.0	62.9	80.3	100.0

Notes: means are calculated on the transformed scale and will differ slightly from the simple means.
'Upper', 'Middle' and 'Lower' refer to leaf layers on which disease severity was assessed on a 0-5 scale and converted to a disease index (0-100). 'All' is an average of the top, middle and bottom values, after imputing missing values.

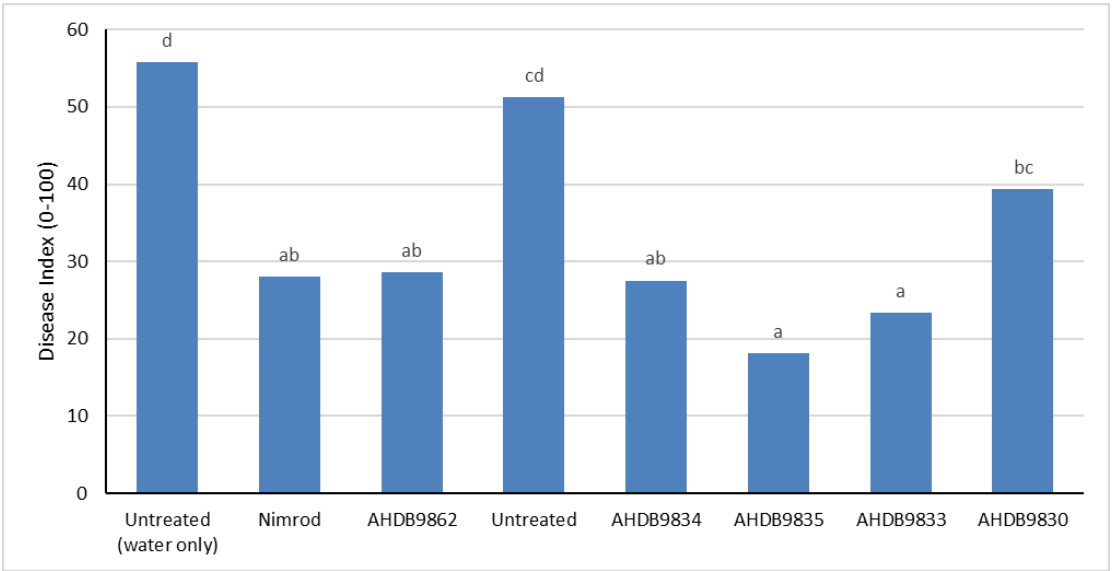


Figure 2: Disease Index averaged across all leaf layers on 09.09.19

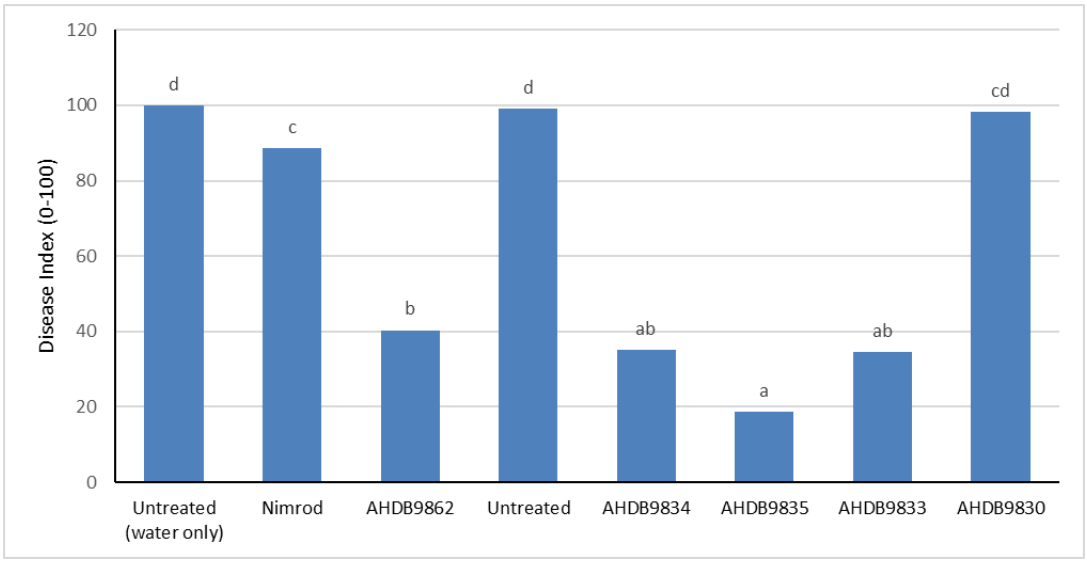


Figure 3: Disease Index averaged across all leaf layers on 18.09.19

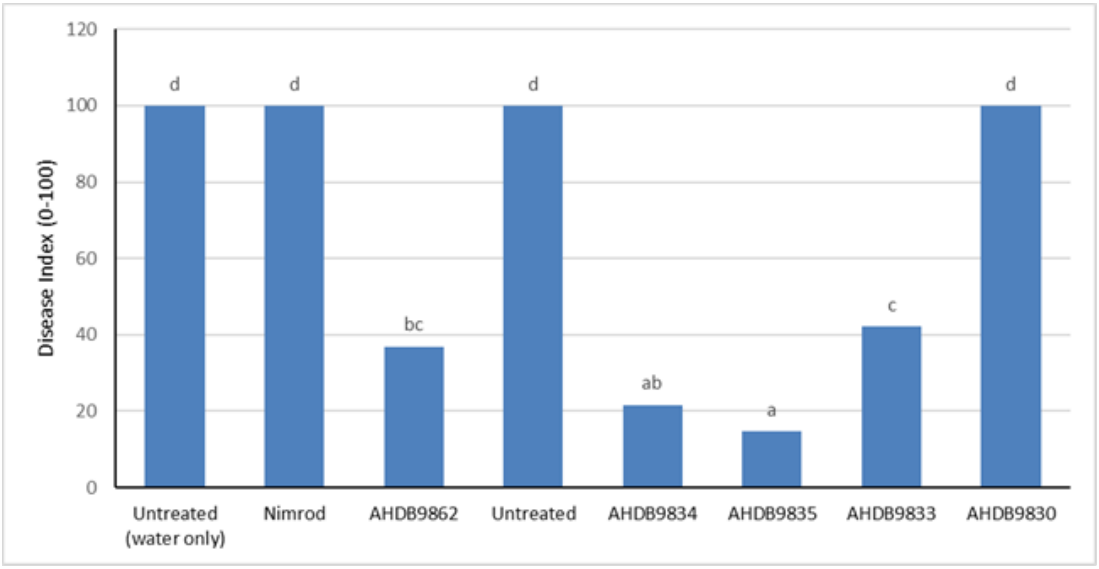


Figure 4: Disease Index averaged across all leaf layers on 24.09.19

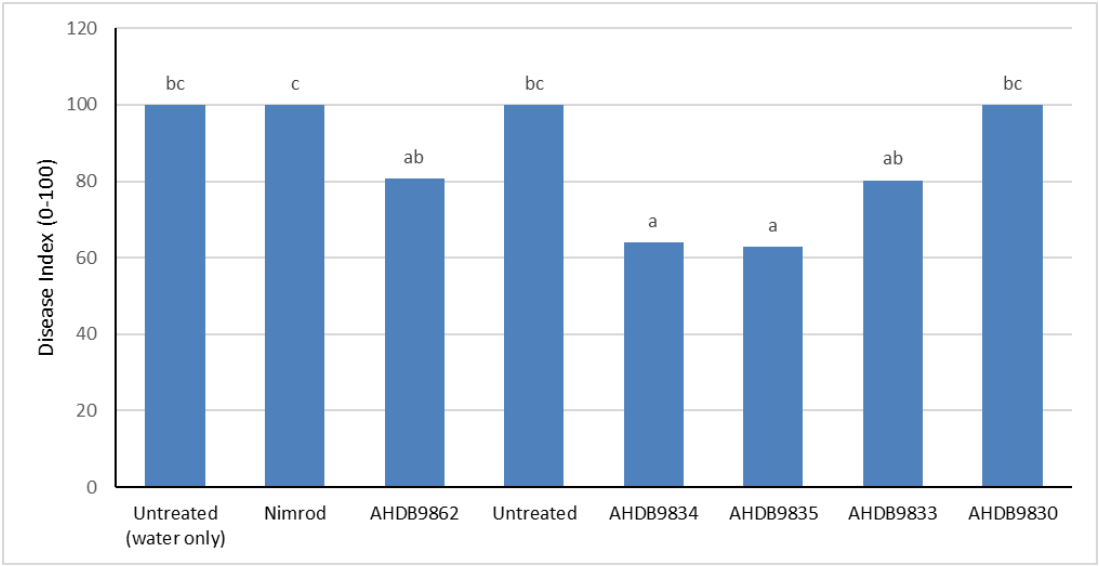


Figure 5: % leaf area affected 07.10.19

Discussion

The crop established well and without any infection, as planned. Once the crop was well-established and inoculum had been introduced, disease developed rapidly and evenly across the crop and treatment applications were made as planned.

- On the 4th September (before any treatments were applied) there were no significant differences in incidence of powdery mildew between the 8 treatments.
- 5 days after the first application of treatments (09.09.19) all but treatment 4 had significantly reduced the level of powdery mildew present. Treatments 2, 5, 6 and 7 were significantly different to the untreated control at all layers, and Treatment 3 was significantly different except at the bottom layer. In addition, Treatment 8 was significantly different from the control for the overall mean value.
- On 18.09.19 (14 days after the first application of treatments and 7 days after the second application of biopesticides) Treatments 3, 5, 6 and 7 were significantly different to the untreated control at all leaf layers. Treatment 2 (Nimrod, the standard) was significantly different for the top layer and the overall assessment, but not for the lower leaf layers.
- By 24th September there were too many missing values in the bottom layer to permit a valid analysis, but Treatments 3, 5, 6 and 7 were significantly different to the control for the layers and for the overall average.
- For the final assessment (over a month after treatment application) of leaf area affected only Treatments 5 and 6 were significantly different to the control for the percentage of leaf area affected by powdery mildew.

Conclusions

Nimrod was the cucumber industry standard product for powdery mildew control and the approval for this product has recently changed to effectively permit only one application of the product per crop. One application of Nimrod in this trial did not provide sustained control of the disease and the requirement for additional product approvals for control of powdery mildew in cucumber is clear.

Disease levels were relatively high at the first application of products and this provided a stern test of the treatments. All products significantly reduced levels of mildew infection at the first assessment date and this indicates that all products could be of interest in situations where disease pressure was lower.

Both biopesticides in the trial gave a significant reduction in disease but AHDB9833 reduced disease by approximately 60% and would be of particular interest for approval.

Two conventional fungicides (AHDB9834 and AHDB9835) were still providing a level of control over a month after the first application of products, which, given the level of disease in the glasshouse, makes them good candidates for the knock-down type products sought by the cucumber growers.

Acknowledgements

We would like to thank AHDB and the participating crop protection companies for project funding. We would also like to thank Derek Hargreaves for providing inoculum for the trial and for invaluable technical advice and guidance.

Appendix

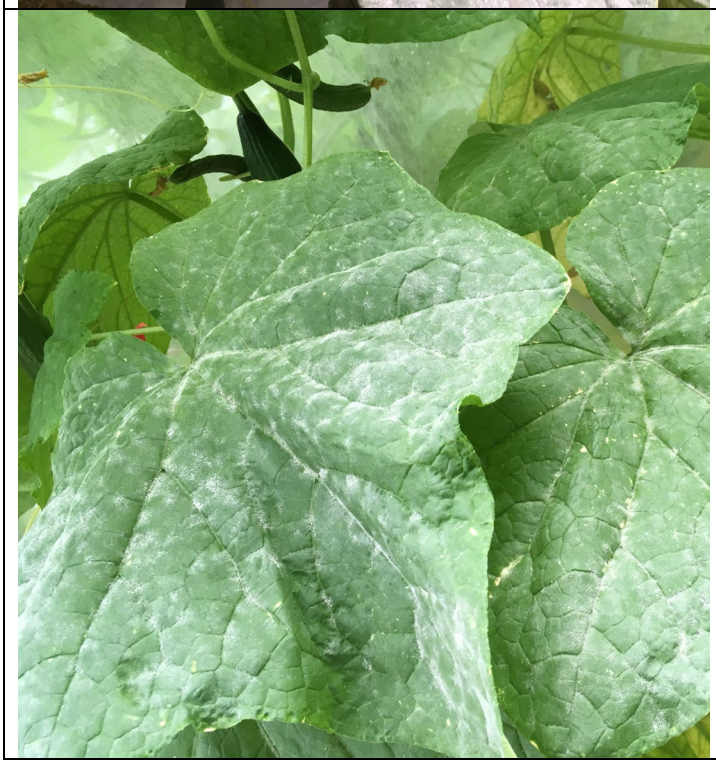
Appendix A: Crop diary

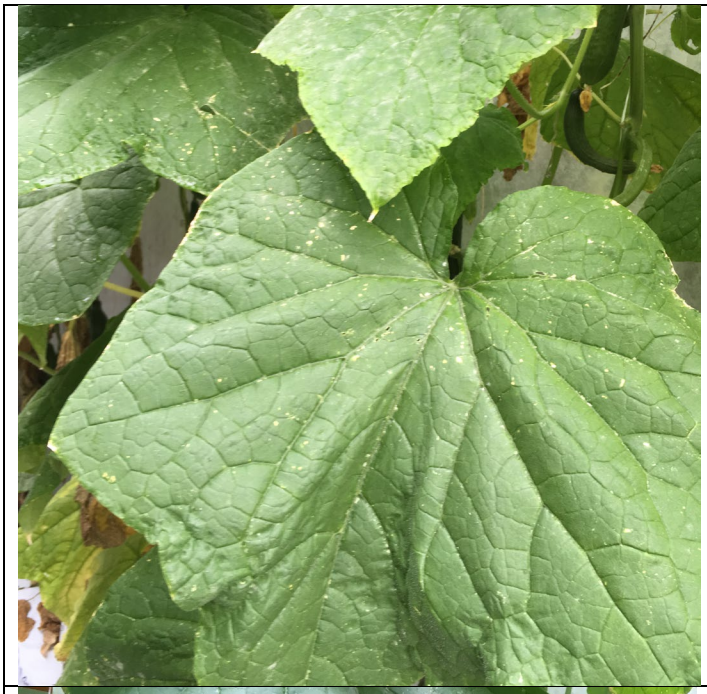
Date	Action
15.07.19	Seed planted into rockwool blocks
05.08.19	Plants planted out onto rockwool slabs
06.08.19	Crop treated with Takumi (0.15 l/ha)

Appendix B: Trial diary

Date	Action
21.08.19	Crop inoculated- infected leaf material shaken over crop at approx. 1m high across all plots
04.09.19	Baseline assessment of powdery mildew infection
04.09.19	First application of treatments (all treatments)
09.09.19	Assessment of phytotoxicity and powdery mildew
11.09.19	Second application of treatments (biopesticides only)
18.09.19	Assessment of phytotoxicity and powdery mildew
24.09.19	Assessment of phytotoxicity and powdery mildew
02.10.19	Assessment of phytotoxicity and powdery mildew
07.10.19	Final assessment of phytotoxicity and powdery mildew

Appendix C: Photographs
Representative photo of each treatment on 24.09.19

	T1 Untreated (water only)
	T2 Nimrod

	T3 AHDB9862
	T5 AHDB9834

	T6 AHDB9835
	T7 AHDB9833

	T8 AHDB9830

Appendix D: Climatological data during study period

	Max Temp °C	Min Temp °C	Mean RH %
01/08/2019	29.3	16.0	99.0
02/08/2019	31.4	16.3	99.0
03/08/2019	34.3	15.4	99.2
04/08/2019	32.2	19.1	99.1
05/08/2019	32.2	17.7	99.0
06/08/2019	29.5	17.0	99.0
07/08/2019	29.3	17.0	99.0
08/08/2019	33.0	15.7	99.1
09/08/2019	30.8	18.8	99.0
10/08/2019	26.5	18.6	99.0
11/08/2019	24.8	15.5	99.0
12/08/2019	27.7	12.1	98.9
13/08/2019	28.9	16.3	72.4
14/08/2019	24.1	15.2	82.1
15/08/2019	29.3	19.2	67.7
16/08/2019	23.9	18.9	82.5
17/08/2019	28.3	18.3	67.3
18/08/2019	27.0	17.4	67.9
19/08/2019	27.3	18.4	72.6
20/08/2019	26.8	17.4	71.6
21/08/2019	28.0	19.3	78.3
22/08/2019	25.9	20.1	79.3
23/08/2019	32.4	19.9	76.4
24/08/2019	30.3	19.9	71.6
25/08/2019	32.5	19.0	74.7
26/08/2019	33.4	19.6	77.5
27/08/2019	34.4	20.0	80.0
28/08/2019	26.6	19.9	83.3
29/08/2019	26.1	17.5	75.9
30/08/2019	26.2	20.0	79.1
31/08/2019	26.0	18.5	81.2
01/09/2019	26.1	17.4	78.7
02/09/2019	24.0	17.4	84.6
03/09/2019	25.0	19.4	84.9
04/09/2019	25.0	17.5	85.9

	Max Temp °C	Min Temp °C	Mean RH %
05/09/2019	25.6	17.5	80.9
06/09/2019	25.5	17.9	83.1
07/09/2019	24.9	17.5	82.5
08/09/2019	26.8	17.9	80.0
09/09/2019	21.5	17.9	86.9
10/09/2019	26.4	17.3	82.6
11/09/2019	25.6	16.9	86.7
12/09/2019	25.2	16.1	88.7
13/09/2019	26.2	11.0	86.0
14/09/2019	25.5	9.9	87.4
15/09/2019	23.9	15.4	91.6
16/09/2019	25.2	14.1	89.0
17/09/2019	24.9	10.0	87.1
18/09/2019	24.8	8.8	87.6
19/09/2019	26.9	17.3	82.7
20/09/2019	26.2	15.2	83.9
21/09/2019	26.7	11.0	84.2
22/09/2019	25.5	14.2	90.2
23/09/2019	25.8	16.8	88.4
24/09/2019	22.7	17.4	94.1
25/09/2019	25.7	16.2	90.9
26/09/2019	25.2	16.0	89.6
27/09/2019	25.4	13.9	91.3
28/09/2019	24.8	14.0	90.1
29/09/2019	18.0	14.2	94.1
30/09/2019	25.8	10.9	87.7
01/10/2019	19.8	11.0	90.8
02/10/2019	25.4	7.2	86.4
03/10/2019	23.9	7.0	85.1
04/10/2019	25.3	15.4	86.4
05/10/2019	24.7	15.6	86.4
06/10/2019	24.7	13.7	90.0
07/10/2019	20.5	12.7	91.1

Appendix E: Raw data from assessments

		4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19	4.9.19
	Plant	1	1	1	2	2	2	3	3	3	4	4	4
Trt	↓Plot no./Leaf→	top	middle	bottom	top	middle	bottom	top	middle	bottom	top	middle	bottom
5	1	0	1	2	0	1	5	0	1	2	0	1	4
7	2	0	0	3	0	2	2	0	2	3	0	1	2
6	3	0	0	1	0	0	3	0	0	5	0	3	4
8	4	0	2	1	0	1	4	0	2	5	0	0	4
3	5	0	5	5	0	2	3	0	2	5	0	1	5
1	6	0	2	5	0	4	5	0	3	4	0	2	5
4	7	0	3	5	0	3	5	0	2	4	0	2	4
2	8	0	1	2	0	0	5	0	3	2	0	2	3
1	9	0	5	4	0	1	5	0	3	4	0	1	4
8	10	0	0	2	0	0	5	0	0	5	0	1	3
5	11	0	1	2	0	3	5	0	0	2	0	0	4
7	12	0	0	3	2	3	2	0	1	2	0	1	3
6	13	0	1	2	0	0	2	0	0	1	0	0	2
3	14	0	0	2	0	0	0	0	0	2	0	1	2
2	15	0	0	4	0	0	1	0	1	1	0	1	4
4	16	0	0	2	0	2	5	0	0	4	0	1	5
7	17	0	2	5	0	2	5	0	0	4	0	2	4
4	18	0	0	5	0	0	5	0	1	2	0	1	2
8	19	0	1	3	0	0	3	0	0	4	0	2	3
6	20	0	1	5	0	2	4	0	1	5	0	0	5
2	21	0	2	5	0	3	4	0	1	4	0	2	5
5	22	0	0	4	0	1	3	0	1	4	0	0	5
1	23	0	0	5	0	0	5	0	1	4	0	2	5
3	24	0	1	5	0	2	5	0	0	5	0	0	2
6	25	0	3	5	0	2	4	0	2	3	0	2	3
8	26	0	1	2	0	1	4	0	1	3	0	1	3
2	27	0	0	2	0	0	2	0	2	3	0	0	3
5	28	0	0	2	0	0	4	1	2	3	0	0	3
3	29	0	2	3	0	3	5	0	1	4	0	0	4
1	30	0	2	2	0	1	2	0	0	2	0	0	2
7	31	0	2	2	0	0	5	0	1	3	0	0	4
4	32	0	3	3	0	0	3	0	2	4	0	0	3
2	33	0	0	3	0	0	2	0	1	2	0	0	2
6	34	0	0	0	0	0	1	0	0	3	0	0	3
3	35	0	0	3	0	0	2	0	0	1	0	0	3
1	36	0	0	2	0	0	2	0	0	0	0	1	1
8	37	0	2	4	0	0	3	0	2	4	0	0	4
4	38	0	0	2	0	1	3	0	0	0	0	3	4
5	39	0	0	2	0	0	3	0	0	1	0	0	2
7	40	0	0	2	0	0	1	0	0	4	0	1	3
4	41	0	0	4	0	1	4	0	0	2	0	2	4
2	42	0	1	4	0	2	4	0	0	4	0	0	2
1	43	0	0	4	0	0	3	0	0	3	0	0	3
8	44	0	0	4	0	1	4	0	0	5	0	0	2
7	45	0	0	4	0	0	3	0	0	3	0	0	3
5	46	0	1	4	0	2	4	0	0	3	0	2	5
6	47	0	1	4	0	1	5	0	0	3	0	1	4
3	48	0	0	5	0	2	5	0	0	5	0	0	3

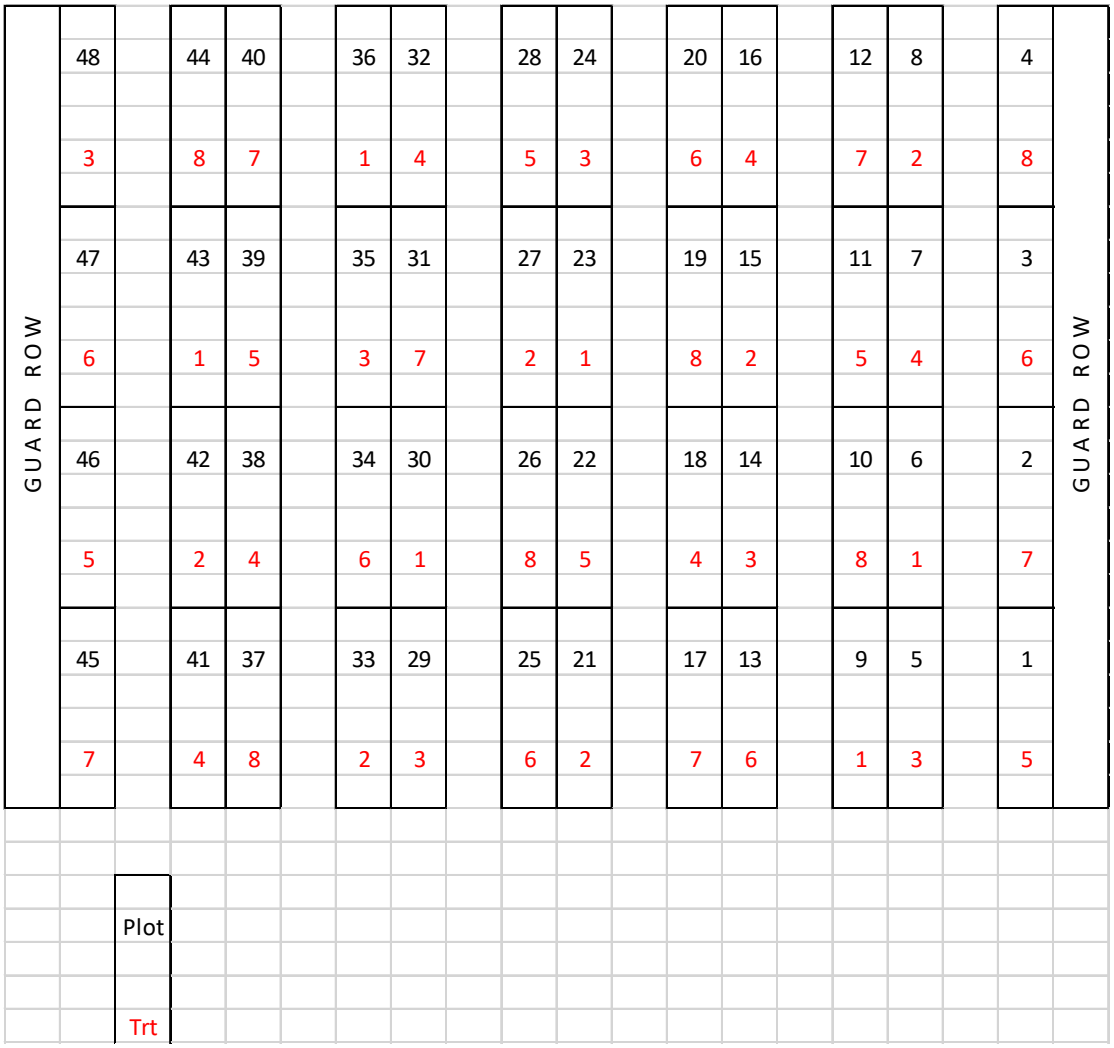
		9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19	9.9.19
	Plant	1	1	1	2	2	2	3	3	3	4	4	4
Trt	↓Plot no./Leaf→	top	middle	bottom	top	middle	bottom	top	middle	bottom	top	middle	bottom
5	1	0	2	3	1	1	2	0	2	4	0	1	2
7	2	0	1	3	0	1	0	0	2	1	0	1	1
6	3	0	0	0	0	0	2	0	0	3	0	3	2
8	4	2	2	2	2	2	4	2	3	4	2	3	4
3	5	1	4	4	1	2	2	0	2	2	0	1	3
1	6	2	3	5	2	5	5	2	3	5	2	2	5
4	7	0	1	3	2	3	5	2	2	4	2	3	4
2	8	1	1	2	1	2	2	0	3	3	1	3	3
1	9	2	5	4	1	2	4	1	2		1	1	
8	10	0	1	1	0	0	3	1	1		1	1	
5	11	0	0	1	0	2	2	0	1	2	0	0	3
7	12	2	1	2	1	1	1	1	2	2	1	2	3
6	13	0	0	1	0	0	0	0	0	1	0	0	2
3	14	0	0	1	1	0	0	0	0	2	0	1	1
2	15	0	0		0	1		0	1	1	0	0	3
4	16	2	1	3	2	3	5	2	2	4	2	5	5
7	17	2	2	4	2	2	3	1	1	2	1	2	2
4	18	2	2	5	3	2	5	1	2	3	2	2	3
8	19	2	2	3	1	2	3	2	2	3	1	2	4
6	20	2	1	4	0	1	3	1	1	5	0	1	4
2	21	2	2	2	0	2	3	0	1	3	2	1	3
5	22	1	2	4	1	2	3	0	1	3	1	1	4
1	23	2	2		1	0	5	2	3	4	3	3	5
3	24	2	2	4	1	2	4	0	1	5	0	2	3
6	25	1	2	3	0	0	3	1		3	0	1	2
8	26	0	2		1	2		0	1	3	0	2	3
2	27	1	0	2	1	2	2	1	2	2	1	0	3
5	28	0	0	2	0	2	3	1	2	4	1	2	4
3	29	2	2	3	0	2	3	0	2	4	0	0	3
1	30	3	3	3	1	4	3	2	1	3	3	4	4
7	31	1	1	1	0	1	2	0	2	2	0	0	2
4	32	2	3	4	2	2	4	2	3	5	2	3	5
2	33	0	1		1	0		2	1		0	2	2
6	34	0	0	0	0	0		0	0		0	0	2
3	35	0	0		0	1	2	0	0	1	0	0	3
1	36	2	0		2	2	2	1	1	1	2	3	2
8	37	1	2	5	2	1	4	2	2	3	2	0	
4	38	0	1		1	0		3	1	2	2	3	
5	39	0	1		0	1		0	0	1	0	0	0
7	40	2	0	2	0	0	2	0	0	1	0	2	3
4	41	2	2	4	2	2	5	2	1	3	2	3	4
2	42	0	1	4	0	3	3	0	2		0	0	2
1	43	3	2	5	2	2	4	2	0	4	2	2	
8	44	2	2	3	1	3	4	2	0	3	1	1	3
7	45	0	0	3	0	1	2	0	0	2	1	1	
5	46	0	2	3	0	2		0	0	3	1	2	3
6	47	0	1	2	0	1	4	0	0	2	0	1	2
3	48	1	2	4	0	2	4	2	1	4	2	2	3

		18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19	18.9.19
	Plant	1	1	1	2	2	2	3	3	3	4	4	4
Trt	↓Plot no./Leaf→	top	middle	bottom	top	middle	bottom	top	middle	bottom	top	middle	bottom
5	1	1	2	3	2	1	2	0	2		1	1	
7	2	1			0	0	0	0			1		0
6	3	0	0		0	0	2	0	0	2	0	2	
8	4	5	5		5	5	5	5	5	5	5	5	5
3	5	5	5	4	1	1	1	0	2		2	2	
1	6	5	5		5	5		5			5	5	
4	7	4	5		5	5		5	5		5	5	
2	8	3	3		3	5	5	4	5		4	5	5
1	9	5			5			5			4		
8	10	4	4		1	2		5					
5	11	0	2		0			0			0	0	
7	12	3			1			2			2	3	
6	13	0	1	1	0	0		0			0	0	
3	14	0	0		1	2		0			0		
2	15	4	2		4	5		2			4		
4	16	5	3	5	5	5		5	5		5	5	5
7	17	3	2	5	2	3	3	1	2		2	2	
4	18	5	5		5	5		5	5		5	5	5
8	19	5	5	5	5	5	5	5	5	5	5	5	5
6	20	3	2		0	0	4	4	1	2	2	1	
2	21	5	5	5	5	5	5	4	3	5	5	4	5
5	22	1	2		2	2	3	1	2	4	1	1	2
1	23	5	5		5	5	5	5	5		5	5	5
3	24	2	2	5	5	3	5	1	2	4	4	1	4
6	25	1			0	0		0			0		
8	26	5	5		5	5		5	5		5		
2	27	5	2		4	5		5	5		5	3	5
5	28	0	2	2	1	2		1	2		2	2	5
3	29	1	5	2	1	2	3	1	2		1	2	2
1	30	5			5	5		5	4		5	5	
7	31	3		2	0	3		1	2		0		2
4	32	5	5	5	5	5	5	5	5	5	5	5	5
2	33	5			4	5		5			5		
6	34	0	0		0	0		1	0		1	0	
3	35	0			5			0	0		0	0	
1	36	5	5		5	5	5	5	5	5	5	5	5
8	37	5	5		5	5		5	5		5		
4	38	5			3			5	5		5	5	
5	39	1			1	1			0		0	0	
7	40	1	1	2	0	0		3	0		0	3	4
4	41	5	5	5	5	5		5		5	5	5	
2	42	5	5		5			5	5		5	2	4
1	43	5	5		5	5		5	5		5	5	
8	44	5	5	5	5	5		5	5		5	3	
7	45	1	0	4	1	3		3	0		0	0	
5	46	2	2		0			2	2		1	3	
6	47	0	1		1	1		1	0		0	1	
3	48	1	2		1	2		5	0		1	2	4

		24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19	24.9.19
	Plant	1	1	1	2	2	2	3	3	3	4	4	4
Trt	↓Plot no./Leaf→	top	middle	bottom	top	middle	bottom	top	middle	bottom	top	middle	bottom
5	1	0	2		2	1		0	3		1	3	
7	2	2			0	1		1			2		
6	3	0	0		0			0	0	1	0	2	
8	4	5	5		5	5		5	5		5	5	
3	5	2	5	4	2	2		0	2		3	4	
1	6	5			5			5			5		
4	7				5	5		5	5		5	5	
2	8	5	5		5	5					5	5	5
1	9	5			5			5			5		
8	10	4			5	5		5					
5	11	0			0			0			0		
7	12	4						0			3	3	
6	13	0	1	0	0	0		0			0	0	
3	14	0			0	1	0	0			0		
2	15	5	5		5			5			5		
4	16	5	5	5	5	5		5	5		5	5	
7	17	4	2	5	2	3	4	1	2		2		
4	18	5	5		5	5		5	5		5		5
8	19	5	5	5	5	5		5	5		5	5	
6	20	4	1		0	1	3	4	2		3	0	
2	21	5	5	5	5	5		5	5	5	5	5	
5	22	2	1		2	1	2	1	1		1	1	
1	23	5	5		5	5		5	5		5	5	5
3	24	5	4	5	1	2		2	2		5	2	5
6	25	2			0	0		1			1		
8	26	5			5			5			5		
2	27	5	5		5	5		5			5	5	
5	28	0	1	1	1	3		1	1		1	1	4
3	29	4	4		1	2		0	1		0	0	
1	30	5			5			5			5		
7	31	2			1	3		1	2		0		
4	32	5		5	5	5		5			5	5	5
2	33	5			5			5			5		
6	34	0	0		0	0		0	0		3	0	
3	35	0			4			0	0		0		
1	36	5			5	5	5	5	5	5	5	5	5
8	37	5			5	5		5					
4	38	5			5			4			5		
5	39	0			0				0		0		
7	40	1	1		0			4	0		4	4	
4	41	5	5	5	5			5			5		
2	42	4	5		5			5			5	5	
1	43	5			5	5		5	5		5	5	
8	44	5	5		5	5		5	5		5	5	
7	45	2	0	2	2	2		4	0		1	0	
5	46	0	1		2			1	0		0		
6	47	0	1		1	0		0	0		0	0	
3	48	0	3		0	3		5	0		3	3	3

	Average % Leaf area affected by powdery mildew.			
	07.10.19	07.10.19	07.10.19	07.10.19
Plot/Plant	1	2	3	4
1	25	5	20	25
2	30	25	25	30
3			10	10
4	100	100	100	100
5	60	40	50	70
6		100	100	100
7	100	100	100	100
8	100	100		100
9	100	100	100	100
10			100	
11	20	20	50	50
12	100	75	80	90
13	60	50	75	90
14	25	30		20
15		100	100	100
16	100	100	100	100
17	50	30	50	
18	100	100	100	100
19	100	100	100	100
20	10	40	10	50
21	100	100	100	100
22	75	90	20	50
23	100	100	100	100
24	50	60	50	60
25	70	95	95	100
26	100	100		
27	100		100	100
28		75	60	100
29	100	100	90	95
30	100			
31				95
32	100	100	100	100
33	100	100	100	100
34	90	95	85	75
35	100	100	100	95
36	100	100	100	100
37		100	100	
38		100		100
39		100		100
40	100	100	95	95
41	100	100	100	100
42	100	100	100	
43			100	100
44	100	100	100	100
45	95	100	95	90
46	95	70	50	75
47	95	90	90	60
48	100	100	100	100

Appendix F: Trial design



Appendix G: ORETO Certificate

Certificate of

Official Recognition of Efficacy Testing Facilities or Organisations in the United Kingdom

This certifies that

Stockbridge Technology Centre

complies with the minimum standards laid down in Regulation (EC) 1107/2009 for efficacy testing.

The above Facility/Organisation has been officially recognised as being competent to carry out efficacy trials/tests in the United Kingdom in the following categories:

Agriculture/Horticulture
Biologicals and Semiochemicals
Stored Crops

Date of issue: 19 July 2016
Effective date: 1 April 2016
Expiry date: 31 March 2021

Signature *Authorised signatory*

Certification Number
ORETO 372

HSE
Chemicals Regulation Division

Department of Agriculture and Rural Development