

SCEPTREPLUS

Final Trial Report

Trial code:	SP54
Title:	Control of downy mildew in salad onions
Crop	Group: Field vegetables - alliums (salad onions)
Target	Downy mildew (<i>Peronospora destructor</i>), PERODE
Lead researcher:	Dr Aoife O 'Driscoll
Organisation:	RSK ADAS Ltd. Boxworth, CB23 4NN
Period:	1 st May 2019 to 31 st January 2020
Report date:	31 st January 2020
Report author:	Dr Aoife O' Driscoll
ORETO Number: (certificate should be attached)	409

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



31/01/2020.....
Date

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Authors signature

Grower Summary

Introduction

Downy mildew caused by *Peronospora destructor* is the most important foliar disease of alliums in the UK. In salad onions, yield losses can be as high as 100%, with whole crops being discarded as downy mildew symptoms on the plant make them unmarketable. Current control measures are prophylactic, relying on a limited number of active ingredients to prevent downy mildew development. This coupled with the threat of non-renewal of some key actives such as metalaxyl-m and ever evolving fungicide resistant strains of downy mildew species means that resistance could become a real problem. A replicated field trial carried out in the West Midlands identified potential new products to effectively manage downy mildew in salad onions.

Methods

The salad onion variety Yoda, planted on 8th July 2019 was used in the trial, located near Cubbington, Warwickshire. The trial was laid out as a randomised complete block design with five replicates of nine treatments and ten replicates of the untreated control. The crop was managed as per commercial practice with the exception that no other fungicides were applied to the trial area. A Burkhardt spore trap was placed in the field to monitor for the presence of aerial spores of downy mildew and thus determine infection risk. The first treatments were applied to plants when the third true leaf was visible, at approximately BBCH13. Fungicides were applied 8-12 days apart depending on weather patterns which dictated choice of spray dates. Assessments were restricted to a 2m row length from each of the central 2 rows of a plot. For the first two assessments when the crop was lightly infected, a whole plot score was made for percentage leaf area affected, with a scale in increments of 5% used to record the % disease within each plot. For the remaining three assessments, 20 onion plants were randomly selected within the marked out area in each plot and scored for degree of infection, by recording the percentage of leaf area on each plant affected with mildew, in increments of 5%. At the end of the trial, approximately twelve days before harvest an independent disease assessment was conducted by Phil Langley to record % total mildew on a per plot basis.

Results

Several treatments had a significant ($p<0.05$) effect both on the incidence and severity of downy mildew. Treatment with AHDB9841 in particular resulted in a significant ($p<0.05$) reduction in both downy mildew incidence and severity at the final three assessments, when downy mildew had become more prevalent in the crop (Table 1, Table 2). By the final assessment treatment with AHDB9841 resulted in 79.3% control of downy mildew, in comparison to the standard treatment which gave just over 70% control (Figure 1). AHDB9827 and AHDB9862 also performed well at these assessments, significantly ($p<0.05$) outperforming the standard treatment at the final assessment with a 77.3% and 78.8% reduction in mildew severity, respectively. AHDB9842 was the poorest performing product in the trial, followed by AHDB9844; giving 29.6% and 38.9% reduction in disease severity respectively by the final assessment, with no significant ($p<0.05$) reduction in downy mildew severity throughout the trial. An independent assessment conducted by Phil Langley shortly before the trial was harvested confirmed the results of the trial. There were no phytotoxic symptoms observed with any of the products tested at any of the assessments.

Table 1: Effect of plant protection products on mean % onion downy mildew incidence

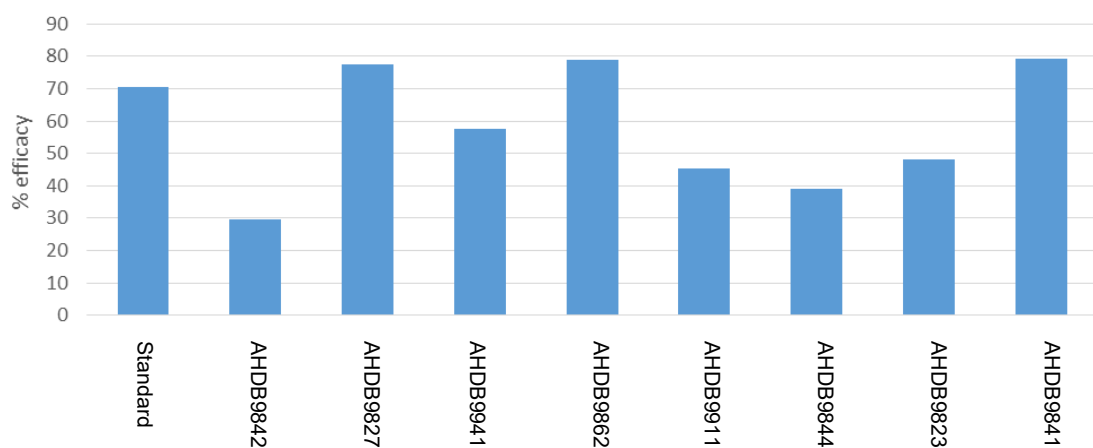
Date	05/09/19	17/09/19	30/09/19	07/10/19	25/10/19
Treatment					
Untreated	1.02	6.5	17.33	36.67	47.5
Standard	0.85	1.75	6.08	15	16.67
AHDB9842	0.7	8.67	12.17	26.67	38.33
AHDB9827	0.5	2.75	3.92	21.67	25
AHDB9941	0.72	4.75	7.33	21.67	33.33
AHDB9862	0.95	2.3	3.67	17.67	28.67
AHDB9911	0.95	7.83	9.5	21.67	36.67
AHDB9844	0.77	7.67	10.58	26.67	40

AHDB9823	0.95	6.58	9	21.67	28.33
AHDB9841	0.83	1.62	3.58	12.5	13.33
P value	0.534	0.006	0.001	0.024	0.014
d.f.	9	9	9	9	9
l.s.d.	0.48	5.90	6.95	17.76	29.59
	Significantly different from untreated control (p>0.05)				
	Not significantly different from untreated control (p>0.05)				

Table 2: Effect of plant protection products on mean % onion downy mildew severity

Date	30/09/19	07/10/19	25/10/19
Treatment			
Untreated	1.02	12.5	17.33
Standard	0.85	1.75	5.1
AHDB9842	0.7	8.667	12.2
AHDB9827	0.5	2.75	3.92
AHDB9941	0.72	4.75	7.33
AHDB9862	0.95	2.3	3.67
AHDB9911	0.95	7.82	9.5
AHDB9844	0.77	7.67	10.58
AHDB9823	0.95	6.58	9
AHDB9841	0.5	0.62	3.58
P value	0.788	<.001	<.001
d.f.	9	9	9
l.s.d.	0.54	4.01	5.31
	Significantly different from untreated control (p>0.05)		
	Not significantly different from untreated control (p>0.05)		

Figure 1: Effect of plant protection products, on % reduction in onion downy mildew severity at the final assessment date.



Conclusions

- Invader is currently the gold standard product against downy mildew in salad onions, however the potential loss of mancozeb puts this product under threat.
- AHDB9827 (a single active product) performed better than AHDB9844/AHDB9823 (dual active products), however the reasons for this are currently unclear.
- AHDB9842 performed poorly.
- AHDB9841, AHDB9862 and AHDB9827 all performed well in the trial and were effective in reducing both the incidence and severity of downy mildew in salad onions.

With the future of mancozeb and metalaxyl-m uncertain, and fungicide resistance development in downy mildew species an ever present threat, these three products provide options with additional modes of action which could be used to inform and develop resistance management strategies against this disease going forward.

- Further work should examine the best performing products from the trial as part of a fungicide program to investigate their efficacy as potential alternatives to both mancozeb and metalaxyl-m.

Take Home Message

AHDB9841, AHDB9862 and AHDB9827 all performed well in the trial and were effective in reducing downy mildew in salad onions. These products could provide additional modes of action to current control programmes and will prove useful in informing future fungicide resistance management strategies.

Summary

Downy mildew caused by *Peronospora destructor* is the most important foliar disease of alliums- including bulb onions, salad onion sets, garlic, shallot and in seed production - in the UK. In salad onions, yield losses can be as high as 100%, with whole crops being discarded as downy mildew symptoms on the plant make them unmarketable. Current control measures are prophylactic, relying on a limited number of active ingredients to prevent downy mildew development. This coupled with the threat of non-renewal of some key actives such as metalaxyl-m means that fungicide resistance could become a real problem. A replicated field trial carried out in the West Midlands identified potential new products to effectively manage downy mildew in salad onions.

Objectives

1. To evaluate the effectiveness of a number of fungicides against downy mildew (*Peronospora destructor*) on salad onions as measured by disease incidence, severity and % efficacy.
2. To monitor the treated crop for phytotoxicity

Trial conduct

UK regulatory guidelines were followed but EPPO guideline 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	Yes
PP 1/135(3)	Phytotoxicity assessment	None
PP 1/181(3)	Conduct and reporting of efficacy evaluation trials including GEP	None
PP1/065(3)	Downy mildews of lettuce and other vegetables	None
PP1/120(02)	Foliage diseases of Allium crops	None

Deviations from EPPO guidance: At treatment timing 2 on 05/09/2019, AHDB9827 was applied at 150g/ha instead of 200g/ha. There were no other deviations.

Test site

Item	Details
Location address	Cubbington, Warwickshire CV32 7UJ
Crop	Salad onions
Cultivar	Yoda
Soil or substrate type	Sandy clay loam
Agronomic practice	Planted on 8 th July 2019,
Prior history of site	Previous crop was winter wheat

Trial design

The trial was laid out as a randomised complete block design with five replicates of nine treatments and ten replicates of the untreated control. The crop was managed as per commercial practice with the exception that no other fungicides were applied to the trial area. Signs labelled 'ADAS Trial Area, No Fungicides' were placed where tramlines enter the trial area, at either end of the trial. Crop agronomy was provided by Phil Langley, G's Fresh.

Item	Details
Trial design:	Randomised Block
Number of replicates:	5
Row spacing:	5cm
Plot size: (w x l)	5m x 2m
Plot size: (m ²)	10m ²
Number of plants per plot:	20 plants from the central 2 rows assessed per plot
Leaf Wall Area calculations	N/A

Treatment details

AHDB Code	Active substance	Product name or manufacturers code	Formulation batch number	Content of active substance in product	Formulation type ¹
N/A	Azoxystrobin	Amistar	GRA7C222D	250 g/l azoxystrobin	SC
N/A	Mancozeb and metalaxyl-L	Fubol Gold	SSP8D1415	64% mancozeb + 3.88% w/w metalaxyl-m	WG
N/A	Fluopicolide + propamocarb hydrochloride	Infito	EM4L024655	62.5 g/l fluopicolide + 625 g/l propamocarb hydrochloride	SC
N/A	Dimethomorph + mancozeb	Invader	1703-5864	75 g/kg dimethomorph + 667 g/kg mancozeb	WG
AHDB9842	N/D	N/D	N/D	N/D	N/D
AHDB9827	N/D	N/D	N/D	N/D	N/D
AHDB9941	N/D	N/D	N/D	N/D	N/D
AHDB9862	N/D	N/D	N/D	N/D	N/D
AHDB9911	N/D	N/D	N/D	N/D	N/D
AHDB9844	N/D	N/D	N/D	N/D	N/D
AHDB9823	N/D	N/D	N/D	N/D	N/D
AHDB9841	N/D	N/D	N/D	N/D	N/D

1 OD, oil dispersion; SC, suspension concentrate; WG, water dispersible granule; SL, soluble concentrate

Methods, assessments and records

The first treatments were applied to plants when the third true leaf was visible, at approximately BBCH13. Fungicides were applied 8-12 days apart depending on weather patterns which dictated choice of spray dates. By the second full assessment on 17/09/2019, there were minimal symptoms of downy mildew observed in the trial; the trial was thus artificially inoculated to encourage disease development and ensure a merited test of the products being screened. This was done by walking through each plot once and back, carrying one diseased bulb onion in each hand, with the aim of wafting spores of downy mildew through the plots. The bulb onions were obtained a week before the inoculation from a variety trial being conducted by Bruce Napier, NIAB at the AHDB Horticulture Onion Strategic Farm site, Colchester, Essex.

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	Adjuvant
1	Untreated	N/A	N/A	N/A	N/A
2	Untreated	N/A	N/A	N/A	N/A
3	Amistar	250 ml	1.0 L	A	No
3	Fubol Gold	1276g + 7.4g	1.9 kg	B	No
3	Infinito	100g + 1000g	1.6 L	C	No
3	Invader	187.5g + 1667.5g	2.5 L	D,E	No
4	AHDB9842	N/D	1.25 L	ABCDE	No
5	AHDB9827	N/D	0.2 kg	ABCDE	No
6	AHDB9941	N/D	2.5 L	ABCDE	No
7	AHDB9862	N/D	1.5 L	ABCDE	No
8	AHDB9911	N/D	0.75 L	ABCDE	No
9	AHDB9844	N/D	2.5 L	ABCDE	No
10	AHDB9823	N/D	0.6 L	ABCDE	No
11	AHDB9841 + Phase II	N/D	0.2 L + 0.5 L	ABCDE	Yes

Application details

	Application A	Application B	Application C	Application D	Application E
Application date	28/08/2019	05/09/2019	17/09/2019	25/09/2019	02/10/2019
Time of day	11:30-12:30	13:00-13:45	12:50-13:20	11:30-12:00	11:30-12:15
Crop growth stage (Max, min average BBCH)	BBCH13	BBCH13	BBCH15	BBCH19	BBCH41
Crop height (cm)	12-14cm	15-18cm	18-20cm	18-20cm	20-25cm
Crop coverage (%)	10	10	25	25	25
Application Method	Spray	Spray	Spray	Spray	Spray
Application Placement	Foliar	Foliar	Foliar	Foliar	Foliar
Application equipment	OPS	OPS	OPS	OPS	OPS
Nozzle pressure	2-3	2-3	2-3	2-3	2-3
Nozzle type	Flat fan	Flat fan	Flat fan	Flat fan	Flat fan
Nozzle size	02F110	02F110	02F110	02F110	02F110
Application water volume/ha	200 l/ha	200 l/ha	200 l/ha	200 l/ha	200 l/ha
Temperature of air - shade (°C)	22.9	21.25	20.1	18.45	12.1
Relative humidity (%)	70.85	52.5	53.8	79.85	73.95
Wind speed range (m/s)	1-3.2	8.0-8.2	5-11	4.7-10.2	7.5-8.2
Dew presence (Y/N)	N	N	N	N	N
Temperature of soil - 2-5 cm (°C)	N/A	N/A	N/A	N/A	N/A
Wetness of soil - 2-5 cm	N/A	N/A	N/A	N/A	N/A
Cloud cover (%)	100	100	15	100	75

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

Common name	Scientific Name	EPPO Code	Infection level pre-application	Infection level at start of assessment period	Infection level at end of assessment period
Downy mildew	<i>Peronospora destructor</i>	PERODE	0% incidence	0% incidence	47.5% incidence in untreated control 17.33% severity

Assessment details

Assessments were restricted to a 2m row length from each of the central 2 rows of a plot. These individual 2m row lengths were at least 0.5m from plot ends, and marked using canes to maintain these areas throughout the season. For the first two assessments when the crop was lightly infected, a whole plot score was made for percentage leaf area affected, with a scale in increments of 5% used to record the % disease within each plot. For the remaining three assessments, 20 onion plants were randomly selected within the marked out area in each plot and scored for degree of infection, by recording the percentage of leaf area on each plant affected with mildew, in increments of 5%. This score gave both incidence and severity of mildew within the plot. A shaded temperature and humidity logger was positioned within the plant canopy when marking out the trial area to record temperature (min and max) and humidity every hour for the duration of the trial. At the end of the trial, approximately 5 days before harvest an independent disease assessment was conducted by Phil Langley to record % total mildew on a per plot basis.

Evaluation date	Evaluation Timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotox)	Assessment
5/09/19	7	13	Baseline assessment	Disease incidence (downy mildew)
17/09/19	19	13	Phytotoxicity and efficacy	Phytotoxicity Disease incidence and severity (downy mildew)
30/09/19	32	19	Phytotoxicity and efficacy	Phytotoxicity Disease incidence and severity (downy mildew)
7/10/19	39	41	Phytotoxicity and efficacy	Phytotoxicity Disease incidence and severity (downy mildew)
25/10/19	57	43	Phytotoxicity and efficacy	Phytotoxicity Disease incidence and severity (downy mildew)
11/11/2019	74	49	Efficacy	Disease incidence per plot (independent assessment)

* DA – days after application

Statistical analysis

Due to a lack of disease pressure in two of the trial replicates, the trial data was analysed using three replicates of the nine treatments and six replicates of the untreated control. Statistical analysis was carried out using ANOVA in Genstat 12.2, using disease incidence and severity values as variables. No data transformation was required.

Using disease severity data from the final assessment on the 25th October, % efficacy of each product was calculated using the following formula.

$$\text{Percentage control} = 1 - \frac{\text{Disease severity of treatment}}{\text{Disease severity of untreated}} \times 100$$

Results

Phytotoxicity

There were no phytotoxic symptoms observed with any of the products tested at any of the assessments.

Efficacy

The first visible symptoms of downy mildew were present in untreated plots 13 days after inoculation, with 17.3% of untreated plants infected by third assessment (30/09/19). The results for the mean % onion downy mildew incidence and severity on five assessment dates are presented in Table 3 and Table 4, respectively. The efficacy of each product when compared to disease severity in the untreated controls at the final assessment is presented in Figure 2.

Several treatments had a significant ($p < 0.05$) effect both on the incidence and severity of downy mildew at the different assessment points. Treatment with AHDB9841 in particular resulted in a significant ($p < 0.05$) reduction in both downy mildew incidence and severity at the final three assessments, where downy mildew had become more prevalent in the crop (Table 3, Table 4). By the final assessment treatment with AHDB9841 resulted in 79.3% control of mildew, in comparison to the standard treatment which gave just over 70% control (Figure 2). AHDB9827 and AHDB9862 also performed well at all three assessments, significantly ($p < 0.05$) outperforming the standard treatment with a 77.3% and 78.8% reduction in mildew severity, respectively. AHDB9842 was the poorest performing product in the trial, followed by AHDB9844; giving a 29.6% and 38.9% reduction in severity by the final assessment, with no significant ($p < 0.05$) reduction in downy mildew or severity throughout the trial.

An independent assessment conducted by Phil Langley five days before the field was harvested confirmed the results of the trial.

Table 3: Effect of plant protection products on mean % onion downy mildew incidence at five assessment dates.

Date	05/09/19	17/09/19	30/09/19	07/10/19	25/10/19
Treatment					
Untreated	1.02	6.5	17.33	36.67	47.5
Standard	0.85	1.75	6.08	15	16.67
AHDB9842	0.7	8.67	12.17	26.67	38.33
AHDB9827	0.5	2.75	3.92	21.67	25
AHDB9941	0.72	4.75	7.33	21.67	33.33
AHDB9862	0.95	2.3	3.67	17.67	28.67
AHDB9911	0.95	7.83	9.5	21.67	36.67
AHDB9844	0.77	7.67	10.58	26.67	40
AHDB9823	0.95	6.58	9	21.67	28.33
AHDB9841	0.83	1.62	3.58	12.5	13.33
P value	0.534	0.006	<0.001	0.024	0.014
d.f.	9	9	9	9	9
l.s.d.	0.48	5.90	6.95	17.76	29.59
	Significantly different from untreated control ($p > 0.05$)				
	Not significantly different from untreated control ($p > 0.05$)				

Table 4: Effect of plant protection products on mean % onion downy mildew severity

Date	30/09/19	07/10/19	25/10/19
Treatment			
Untreated	1.02	12.5	17.33
Standard	0.85	1.75	5.1
AHDB9842	0.7	8.667	12.2
AHDB9827	0.5	2.75	3.92
AHDB9941	0.72	4.75	7.33
AHDB9862	0.95	2.3	3.67
AHDB9911	0.95	7.82	9.5
AHDB9844	0.77	7.67	10.58
AHDB9823	0.95	6.58	9
AHDB9841	0.5	0.62	3.58
P value	0.788	<.001	<.001
d.f.	9	9	9
l.s.d.	0.54	4.01	5.31
	Significantly different from untreated control (p>0.05)		
	Not significantly different from untreated control (p>0.05)		

Figure 2: Effect of plant protection products, on % reduction in onion downy mildew severity at the final assessment date.

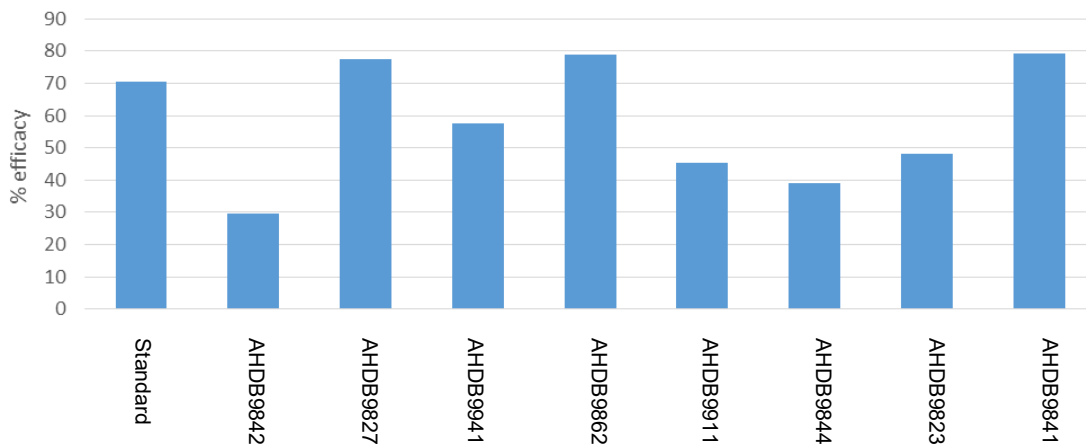
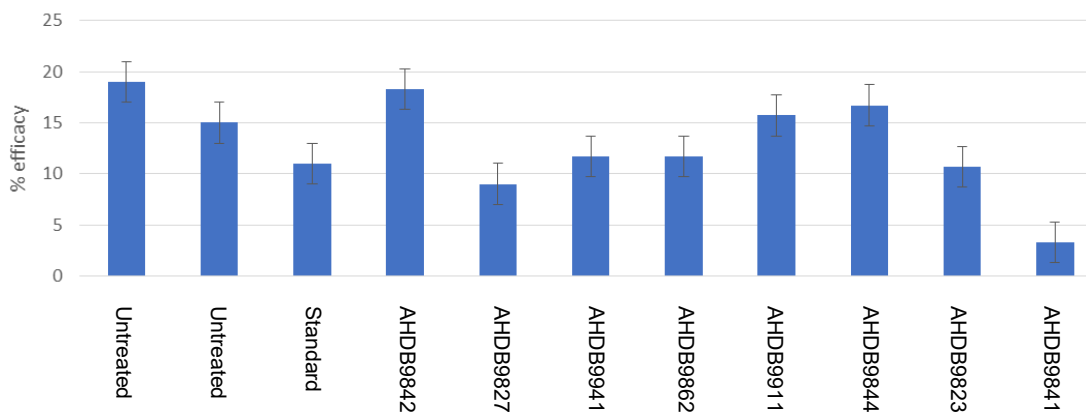


Figure 3: Effect of plant protection products, on mean % onion downy mildew severity, independent assessment conducted twelve days before harvest.



Discussion

Disease levels were patchy in the trial, with a moderate to high level of disease in replicates 1-3, and low disease in the fourth and fifth replicate of the trial. Nonetheless, it provided a merited test of efficacy of the products in what was generally a low disease pressure year for downy mildew in the UK, with clear differences between treatments, AHDB9827 (single active product) performed better in the trial than AHDB9844 and AHDB9823 (dual active products). The reasons for this are unclear; the total amount of AHDB9827 by active per hectare was less than that applied using AHDB9844 or AHDB9823, and there was no clear difference in formulation type. This would need to be discussed further with the manufacturer and relevant agronomists before any further conclusions are drawn. AHDB9841 gained an approval on salad onions in August 2019 for downy mildew control; thus this trial will provide growers with some encouraging confirmation of its efficacy against downy mildew under a moderate to high disease pressure. AHDB9862, a new generation azole fungicide also performed very well in the trial. With the future of mancozeb and metalaxyl-m uncertain, and fungicide resistance development in downy mildew species an ever present threat, the best performing products in the trial; AHDB9827, AHDB9841 and AHDB9862 provide three fungicide options with additional modes of action which could be used to inform and develop resistance management strategies against this disease going forward. Further studies are warranted to examine the efficacy of these products in a programme, for both their protectant and curative activities, as potential alternatives to metalaxyl-m or mancozeb.

Conclusions

- Invader is currently the gold standard product against downy mildew in salad onions, however the potential loss of mancozeb puts this product under threat.
- AHDB9827 (a single active product) performed better than AHDB9844/AHDB9823 (dual active products), however the reasons for this are currently unclear.
- AHDB9842 performed poorly.
- AHDB9841, AHDB9862 and AHDB9827 all performed well in the trial and were effective in reducing both the incidence and severity of downy mildew in salad onions. With the future of mancozeb and metalaxyl-m uncertain, and fungicide resistance development in downy mildew species an ever present threat, these three products provide options with additional modes of action which could be used to inform and develop resistance management strategies against this disease going forward.
- Further work should examine the best performing products from the trial as part of a fungicide program to investigate their efficacy as potential alternatives to both mancozeb and metalaxyl-m.

Acknowledgements

We would like to thank AHDB and the participating crop protection companies for project funding. G's Fresh for hosting the trial and Phil Langley at G's for agronomic advice and conducting a final assessment on the trial.

Appendix

- a. Crop diary – events related to growing crop

Crop	Cultivar	Planting date
Salad onion	Yoda	8 th July 2019

Fertilisers, herbicides and insecticides applied to the trial area

Date	Product	Rate/Unit
10/07/2019	Wing-P	1.3 L/ha
	Stomp Aqua	0.3 L/ha
	Toledo	0.5 L/ha
	Crusade	0.4 L/ha
	Touchdown Quattro	1.5 L/ha
23/07/2019	Wing-P	0.7 L/ha

	Cleancrop Amigo 2	0.7 L/ha
27/07/2019	Cleancrop Amigo 2	1 L/ha
	Stomp Aqua	0.4 L/ha
02/08/2019	Cleancrop Gallifrey 3	0.125 L/ha
12/08/2019	Buctril	0.4 L/ha
20/08/2019	Buctril	0.4 L/ha
23/08/2019	Centurion Max	1.75 L/ha
27/08/2019	Crusade	0.4 L/ha
	YaraVita Magflo 300	1 L/ha
	New-Triton Manganese 15	1 L/ha
	Tracer	0.2 L/ha
03/09/2019	Crusade	0.4 L/ha
	YaraVita Magflo	1 L/ha
10/09/2019	Crusade	0.4 L/ha
	YaraVita CropLift Pro	1.331 L/ha
	Benevia	0.4 L/ha
17/09/2019	Crusade	0.5 L/ha
	YaraVita Magflo 300	1 L/ha

b. Table showing sequence of events by date – this relates to treatments and assessments.

Date	Event
19/08/2019	Trial marked out and some plots hand weeded due to high weed pressure (volunteer WOSR). GS: leaf 3 just emerged.
28/08/2019	T1 spray and background assessment complete
05/09/2019	T2 spray and assessment carried out. AHDB9827 was applied at 150 g/ha instead of 200 g/ha. Hand weeded some of the worst weed affected plots
17/09/2019	T3 spray and assessment carried out, no phyto seen. Plots hand weeded.
25/09/2019	T4 spray applied
30/09/2019	Fourth assessment conducted
02/10/2019	T5 spray applied
07/10/2019	Assessment 5 conducted
25/10/2019	Final assessment

c. Table showing readings from Burkhardt spore trap, supplied by Phil Langley, G's Fresh. Readings above 95 are low risk, reading less than 90 are higher risk.

Date sampled	Date tested	Test reading (T)	Downy mildew risk
22/08/2019	11/10/2019	58	High
24/08/2019	11/10/2019	56	High
26/08/2019	11/10/2019	58	High
29/08/2019	11/10/2019	48	High
31/08/2019	11/10/2019	64	High
02/09/2019	11/10/2019	45	High
05/09/2019	11/10/2019	52	High
07/09/2019	11/10/2019	48	High
09/09/2019	11/10/2019	53	High
12/09/2019	11/10/2019	63	High
14/09/2019	11/10/2019	64	High
16/09/2019	11/10/2019	66	High

20/09/2019	11/10/2019	60	High
23/09/2019	11/10/2019	64	High
24/09/2019	11/10/2019	69	High
26/09/2019	11/10/2019	70	High
28/09/2019	11/10/2019	63	High
30/09/2019	11/10/2019	59	High

c. Photographs



i) Trial layout, ii) Burkhardt spore trap in trial area.



Typical downy mildew symptoms in the untreated control plots, at the final assessment date. 25th October 2019.

d. Climatological data during study period

Date	Min Temp °C	Max Temp °C	Average RH %	Average Dew Point (°C)
19/08/2019	12.5	21.5	78.17	12.12
20/08/2019	8.5	22.5	74.56	10.39
21/08/2019	7.5	25	73.58	10.87
22/08/2019	8.5	25.5	73.14	11.92
23/08/2019	10.5	28	72.79	13.27
24/08/2019	9	30.5	74.41	13.54
25/08/2019	12	33	72.75	15.72
26/08/2019	12.5	32	73.60	15.70
27/08/2019	14	32.5	74.97	16.85
28/08/2019	17	25.5	77.87	15.55
29/08/2019	10.5	25	74.81	12.9
30/08/2019	10.5	25.5	77.35	12.90
31/08/2019	10	24.5	78.95	11.82
01/09/2019	9	22.5	73.70	9.71
02/09/2019	5.5	25	74.95	9.62
03/09/2019	13.5	20.5	76.06	12.32
04/09/2019	12.5	20	75.93	11.85
05/09/2019	8	19.5	71.95	8.15
06/09/2019	5	18	81.62	9.02
07/09/2019	7.5	19	80.25	9.57
08/09/2019	4	20	77.14	7.17
09/09/2019	10.5	15.5	88.81	10.78
10/09/2019	8	24	83.75	11.22
11/09/2019	11.5	23	84.62	13.66
12/09/2019	11	28.5	85.87	14.99
13/09/2019	12	26	79.45	13.76
14/09/2019	7	27	81.87	12.31
15/09/2019	7	29	82.41	13.09
16/09/2019	13	23	87.41	14.85
17/09/2019	10.5	24	72.89	11.55
18/09/2019	9	23.5	51.54	6.11
19/09/2019	8.5	18.5	56	5.39
20/09/2019	12.5	17.5	65.56	8.6
21/09/2019	13	19	65.14	9.17
22/09/2019	16	20	68.08	11.84
23/09/2019	15.5	19	68.64	11.29
24/09/2019	16.5	18	73.06	12.34
25/09/2019	15.5	18	74.35	11.90
26/09/2019	15.5	17	72.22	11.92
27/09/2019	14.5	16.5	71.58	10.5
28/09/2019	13	18	73.12	10.02
29/09/2019	15	16	76.41	12.03
30/09/2019	12	16.5	75	9.88
01/10/2019	14	13.5	77.20	11.20
02/10/2019	9	11.5	69.54	5.84
03/10/2019	7.5	13.5	70.70	4.48
04/10/2019	11	14.5	76.31	8.11
05/10/2019	12	13.5	75.5	9.07
06/10/2019	12.5	12.5	77.43	9.00
07/10/2019	10	14	78.5	7.65

08/10/2019	11.5	13	79.29	9.16
09/10/2019	10.5	13	76.35	7.67
10/10/2019	9.5	15.5	76.52	7.35
11/10/2019	13.5	14.5	80.18	11.03
12/10/2019	12.5	14	78.93	9.55
13/10/2019	11.5	12.5	80.35	9.32
14/10/2019	11	13	80.37	8.38
15/10/2019	12	13	81.33	9.43
16/10/2019	10.5	11.5	81.20	8.67
17/10/2019	8.5	12	80.25	6.90
18/10/2019	10.5	12	81.14	7.94
19/10/2019	9.5	11	80.58	7.49
20/10/2019	8	11.5	79.60	6.36
21/10/2019	10	11	81.68	7.65
22/10/2019	9	10.5	80.81	6.94
23/10/2019	7	11.5	80.27	5.76
24/10/2019	10.5	12.5	82.20	8.19
25/10/2019	9	12.5	82.87	7.71

e. Raw data from assessments

Plot No	Assessment Date	05/09/19	05/09/19	17/09/19	17/09/19	30/09/19	30/09/19	07/10/19	07/10/19	25/10/19	25/10/19
	Assessment Type	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
	Treatment Name										
109	Untreated	5	0.68	10	0.45	15	0.45	55	16.5	60	25
207	Untreated	5	0.76	10	0.8	20	0.8	45	5.75	40	16
309	Untreated	10	0.4	15	0.85	25	0.85	40	7.5	50	17
408	Untreated	15	0.68	20	1.05	25	1.05	5	1	20	9
502	Untreated	15	0.52	20	0.9	20	0.9	0	0	0	0
107	Untreated	10	0.52	15	0.25	15	0.25	40	6.5	40	16.75
208	Untreated	25	0.64	30	1.05	35	1.05	60	9.75	60	15.25
303	Untreated	40	0.68	45	1.6	50	1.6	45	6	55	14
407	Untreated	60	0.4	65	3.25	75	3.25	5	1	15	2.25
503	Untreated	35	0.48	45	1.15	55	1.15	0	0	0	0
105	Standard	5	0.48	10	0.3	10	0.3	15	1	35	6.5
210	Standard	25	0.92	30	1.1	30	1.1	35	4.25	45	6.25
311	Standard	20	0.92	25	1.15	35	1.15	0	0	25	5.5
409	Standard	20	0.56	25	0.85	25	0.85	0	0	5	0.5
504	Standard	20	0.48	25	1	30	1	0	0	0	0
104	AHDB9842	30	0.6	35	0.7	40	0.7	60	14	45	10
203	AHDB9842	15	0.72	20	0.5	20	0.5	40	16.5	45	20
302	AHDB9842	40	0.56	45	0.9	50	0.9	15	7	15	6.5
405	AHDB9842	25	0.32	30	0.95	35	0.95	0	0	0	0
511	AHDB9842	45	0.32	50	1.75	55	1.75	0	0	0	0
108	AHDB9845	5	0.72	10	0.4	20	0.4	15	1	25	2.25
206	AHDB9845	20	0.36	25	0.5	30	0.5	50	6.25	55	7.75
305	AHDB9845	15	0.44	25	0.6	30	0.6	10	1	15	1.75
403	AHDB9845	15	0.44	15	0.75	25	0.75	0	0	5	0.5
501	AHDB9845	15	0.36	20	0.85	25	0.85	0	0	0	0
103	AHDB9941	10	0.76	15	0.5	20	0.5	80	6	90	9.75
201	AHDB9941	15	0.96	25	0.65	35	0.65	10	1.25	20	2.75
308	AHDB9941	30	0.24	35	1	40	1	10	7	15	9.5
410	AHDB9941	20	0.64	20	0.9	30	0.9	0	0	15	1
508	AHDB9941	30	0.28	35	1.55	45	1.55	0	0	0	0

Plot No	Assessment Date	05/09/19	05/09/19	17/09/19	17/09/19	30/09/19	30/09/19	07/10/19	07/10/19	25/10/19	25/10/19
	Assessment Type	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
	Treatment Name										
111	AHDB9862	15	0.44	25	0.9	30	0.9	15	0.9	20	2.75
205	AHDB9862	10	0.76	10	0.6	20	0.6	50	6	50	7
307	AHDB9862	25	0.52	30	1.35	45	1.35	5	0	10	1.25
404	AHDB9862	30	0.28	40	0.95	45	0.95	0	0	0	0
510	AHDB9862	25	0.56	30	1.15	35	1.15	0	0	0	0
101	AHDB9911	30	0.32	35	1.05	45	1.05	0	14	30	13.5
209	AHDB9911	15	0.16	15	0.45	25	0.45	30	16.5	55	25
301	AHDB9911	20	0.6	25	1.05	25	1.05	50	3.25	40	6.5
406	AHDB9911	30	0.44	35	1.4	40	1.4	30	1	5	1
509	AHDB9911	20	0.4	30	0.85	35	0.85	5	0	0	0
110	AHDB9844	10	1.16	15	0.7	20	0.7	0	13	60	20.5
202	AHDB9844	25	0.4	30	0.45	35	0.45	65	4.5	30	6
310	AHDB9844	15	0.68	15	1.15	25	1.15	25	5.5	30	5.25
402	AHDB9844	35	0.52	40	0.95	45	0.95	30	0	0	0
507	AHDB9844	50	0.44	55	1.8	60	1.8	0	0	0	0
102	AHDB9823	10	0.4	15	0.4	20	0.4	0	10.25	30	13.5
211	AHDB9823	25	0.56	30	1.2	30	1.2	25	8.5	60	9.75
306	AHDB9823	40	0.24	45	1.25	45	1.25	50	1	20	3.75
411	AHDB9823	35	0.32	40	1.35	45	1.35	10	0	0	0
505	AHDB9823	35	0.28	40	1	45	1	0	0	0	0
106	AHBD9841	0	0.68	5	0.75	10	0.75	0	1.15	20	4.75
204	AHBD9841	30	0.6	30	1.35	35	1.35	20	0.7	25	6
304	AHBD9841	25	0.8	30	0.95	35	0.95	20	0	0	0
401	AHBD9841	35	0.72	45	1.1	50	1.1	0	1	5	1
506	AHBD9841	25	0.6	50	1.5	60	1.5	5	0	0	0



Certificate of

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

This certifies that

RSK ADAS Ltd

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
Stored Crops
Biologicals and Semiochemicals**

Date of issue: 1 June 2018
Effective date: 18 March 2018
Expiry date: 17 March 2023

Signature

Authorised signatory

Certification Number

ORETO 409



Chemicals Regulation Division



Department of
Agriculture and
Rural Development