

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:	Dave Kaye
Organisation:	RSK ADAS Ltd. Boxworth, CB23 4NN
Period:	1 st May 2019 to 31 st January 2020
Report date:	4 June 2020
Report authors:	Dave Kaye
Report authorised by:	Barry Mulholland
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

Date: 5 June 2020

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, total crop loss can occur because of downy mildew infection. Current control measures are prophylactic, relying on a limited number of active ingredients to prevent downy mildew spread. Furthermore, the threat of non-renewal of some key actives such as metalaxyl-M and ever evolving fungicide resistant strains of downy mildew species, could have a significant negative financial impact on UK grower businesses. A field trial carried out in the West Midlands identified potential new crop protection products to effectively manage downy mildew in salad onions.

Methods

The commercial salad onion variety Yoda, was planted on 8th July 2019 at a grower holding, located near Cubbington, Warwickshire. The trial was placed within this crop and laid out as a randomised complete block design, replicated five times. Eight treatments were applied five times starting at growth stage BBCH 12 and repeated every 7-14 days (conditions allowing). Plots were assessed for their efficacy in controlling onion downy mildew incidence and severity. These were compared with a double untreated control and an industry standard programme of Amistar (azoxystrobin, application A), Fubol Gold (mancozeb and metalaxyl-M, application B), Infinito (fluopicolide and propamocarb hydrochloride, application C) and Invader (dimethomorph & mancozeb, applications D and E). A Burkhard spore trap was placed in the field to confirm the presence of *P. destructor* aerial spores.

The crop was managed as per commercial practice with the exception that no other fungicides were applied to the trial area. The first treatments were applied to plants when the third true leaf was visible (BBCH 13). Fungicides were applied 8-12 days apart depending on weather patterns which dictated choice of spray dates. Disease assessments were carried out for 2 m row lengths within each of the central 2 rows for each plot. For the first two assessments when the crop was lightly infected, a whole plot score was made for incidence (percent of plants infected) and severity (percent of leaf area affected), with a scale in increments of 5% used to record both. For the remaining three assessments, 20 onion plants were randomly sampled within the marked out area in each plot. The percentage of symptomatic plants in this sample was recorded (incidence) and the degree of infection (severity) was recorded by assessing the percentage of leaf area exhibiting downy mildew symptoms for each plant per sample, in increments of 5%. At the end of the trial, approximately twelve days before harvest, an independent disease assessment was conducted by Phil Langley (Agronomist, G's) recording the proportion of visible foliar downy mildew symptoms across each entire plot (% severity).

Results

No treatment significantly reduced ($p < 0.05$) downy mildew disease incidence compared with the untreated control at any assessment date (Table 1). Several treatments reduced disease severity by the final two assessments, with all treatments, apart from AHDB9842 significantly reducing ($p < 0.05$) the severity of downy mildew compared with the untreated control by the final assessment. Treatment with DP717, applied in combination with the adjuvant Phase II, in particular, resulted in a significant reduction in downy mildew severity at the final two assessments, where downy mildew had become prevalent in the crop (Table 2). By the final assessment, treatment with DP717 resulted in 79.3% control of downy mildew compared with the untreated control, whilst the industry standard programme gave just under 65% control compared with the untreated (Figure 1).

AHDB9827 and AHDB9862 also performed well, significantly reducing downy mildew severity at the last two assessments. At the final assessment these provided 77.4% and 78.8% control respectively. The industry standard programme performed well as expected, comparable to AHDB9827, AHDB9862 and DP717 and no product provided significantly better control than

the standard programme. The poorest performing product was AHDB9842 which gave no significant reduction in disease severity at any assessment date.

An independent assessment conducted by the Phil Langley shortly before the trial was harvested concur with the results recorded in this study.

Table 1. Effect of plant protection products on mean % onion downy mildew incidence for the final three assessment dates.

Date	30-Sep	07-Oct	25-Oct
Treatment			
Untreated	26.67	47.50	50.83
Standard	25.00	16.67	35.00
AHDB9842	36.67	38.33	35.00
AHDB9827	26.67	25.00	31.67
AHDB9941	31.67	33.33	41.67
AHDB9862	31.67	21.67	26.67
AHDB9911	31.67	36.67	41.67
AHDB9844	26.67	40.00	40.00
AHDB9823	31.67	28.33	36.67
DP717 (+ Phase II)	26.67	13.33	15.00
	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 for the final three assessment dates.

Date	30-Sep	07-Oct	25-Oct
Treatment			
Untreated	1.02	8.67	17.33
Standard	0.85	01.75	6.08
AHDB9842	0.70	12.50	12.17
AHDB9827	0.50	02.75	3.92
AHDB9941	0.72	04.75	7.33
AHDB9862	0.95	02.30	3.67
AHDB9911	0.95	07.83	9.50
AHDB9844	0.77	07.67	10.58
AHDB9823	0.95	06.58	9.00
DP717 (+ Phase II)	0.50	00.62	3.58
	Significantly different from untreated control (p>0.05)		
	Not significantly different from untreated control (p>0.05)		

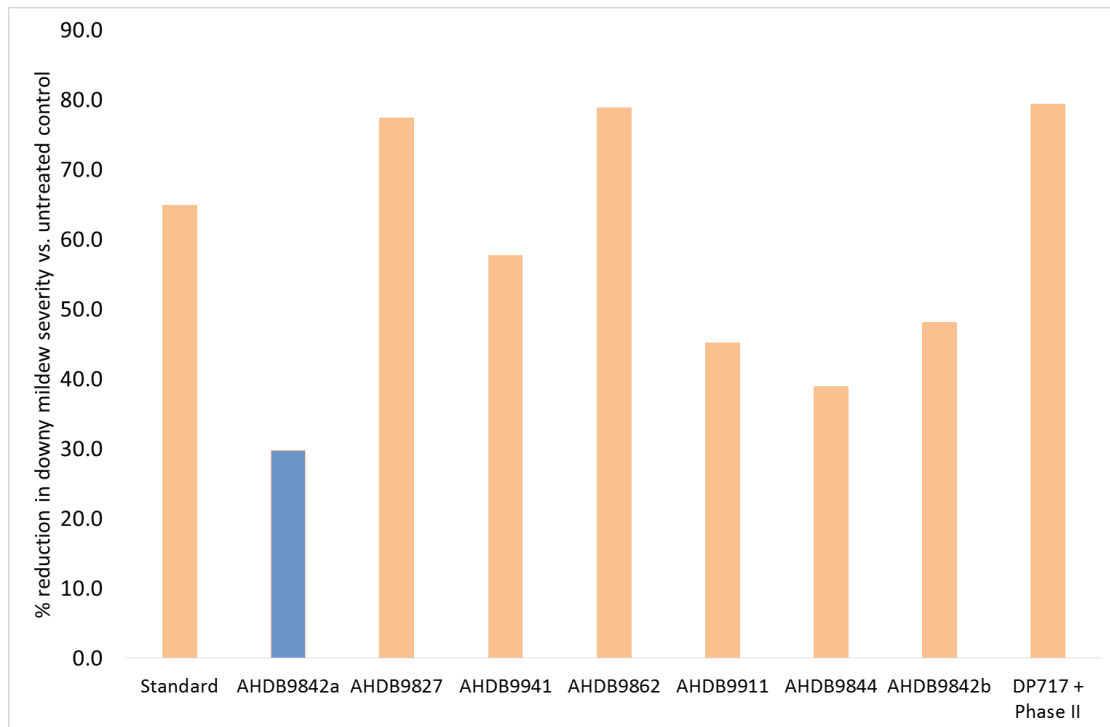


Figure 1. Degree of control of downy mildew severity (%) compared with the untreated control for the different plant protection products and industry standard programme, in field grown salad onion 22 days after the fifth treatment application (25.10.19). Orange bars represent significant reductions in downy mildew severity compared with the untreated control ($P > 0.05$).

Phytotoxicity

No phytotoxic symptoms developed following the application of any test treatments at any assessment date. All products can be considered crop safe at the rates tested.

Conclusions

- Invader (dimethomorph + mancozeb), a component of the industry standard programme used in this work, is currently the gold standard product for downy mildew control in salad onions; however the potential loss of mancozeb puts this product under threat.
- All products tested significantly ($p > 0.05$) reduced downy mildew severity by the final assessment, apart from AHDB9842 which provided no control at any assessment date.
- No product significantly reduced ($p > 0.05$) downy mildew incidence at any assessment date following artificial inoculation.
- DP717 (applied with the adjuvant Phase II), AHDB9862 and AHDB9827 all performed well in the trial and were effective in reducing the severity of downy mildew in salad onions at the final two assessments. 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 different modes of action which could be used to develop resistance management strategies against this disease.
- No product outperformed the industry standard programme, but the performance of DP717, AHDB9862 and AHDB9827 were comparable to this.
- AHDB9827 performed better than AHDB9844 and AHDB9823; however the reasons for this are currently unclear as both products contain the same active as AHDB9827, but in combination with other fungicides.
- Further work could explore 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

DP717, AHDB9862 and AHDB9827 provided the best control in reducing downy mildew in salad onions and were comparable to the industry standard programme. These products could provide additional modes of action to current control programmes and will prove useful in informing future fungicide resistance management strategies. Further work incorporating these products into programmes would identify the most effective products and application timings for onion growers.

Objectives

1. To evaluate the effectiveness of fungicides against downy mildew (*P. 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(4)	Phytotoxicity assessment	None
PP 1/152(4)	Guideline on design and analysis of efficacy evaluation trials	None
PP 1/181(4)	Conduct and reporting of efficacy evaluation trials including good experimental practice	None
PP1/065(3)	Downy mildews of lettuce and other vegetables	None
PP1/120(02)	Foliage diseases of Allium crops	None
PP 1/214(3)	Principles of acceptable efficacy	None
PP 1/224(2)	Principles of efficacy evaluation for minor uses	None

Deviations from EPPO guidance: At treatment timing 2 on 05/09/2019, AHDB9827 was applied at 150 g ha⁻¹ instead of 200 g ha⁻¹. There were no other deviations.

Test site

Item	Details
Location address	Cublington, 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	Winter wheat (2018)

Trial design

Item	Details
Trial design:	Randomised Block
Number of replicates:	5
Row spacing (cm):	5
Plot size: (w x l)	5 x 2
Plot size: (m ²)	10
Number of plants per plot:	Unknown
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	Water	Untreated	N/A	N/A	N/A
N/A	Azoxystrobin	Amistar	GRA7C222D	250 g L ⁻¹	Suspension concentrate
N/A	Mancozeb & metalaxyl-M	Fubol Gold	SSP8D1415	64% w/w 3.88% w/w	Water dispersible granule
N/A	Fluopicolide & propamocarb hydrochloride	Infinito	EM4L024655	62.5 g L ⁻¹ 625 g L ⁻¹	Suspension concentrate
N/A	Dimethomorph & mancozeb	Invader	1703-5864	75 g kg ⁻¹ 667 g kg ⁻¹	Water dispersible granule
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
N/A	Oxathiapiprolin	DP717	PE-7310NOV18CE028	100 g L ⁻¹	Oil dispersion
N/A	Esterified rape seed oil	Phase II	ADJ0622	95% w/w	Adjuvant

Methods, assessments and records

The first treatments were applied to plants when the third true leaf was visible (BBCH 13). 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 and therefore artificial inoculation was carried out by walking through each plot once and back, carrying one diseased bulb onion in each hand, with the aim of spreading *P. destructor* spores through the plots. These 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
1 & 2	Control (water)	-	-	A - E
3	Amistar	250.0	1.00	A
	Fubol Gold	1276.0 & 7.4	1.90	B
	Infinito	100.0 & 1000.0	1.60	C
	Invader	187.5 & 1667.5	2.50	D & E
4	AHDB9842	250.0	1.25	A - E
5	AHDB9827	90.0	0.20	A - E
6	AHDB9941	775.0 & 1325.0	2.50	A - E
7	AHDB9862	112.5.0	1.50	A - E
8	AHDB9911	150.0	0.75	A - E
9	AHDB9844	125.0 & 1000.0	2.50	A - E
10	AHDB9823	108.0 & 150.0	0.60	A - E
11	DP717	20.0	0.20	A - E
	Phase II (adjuvant)	500.0	0.50	A - E

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)	BBCH 13	BBCH 13	BBCH 15	BBCH 19	BBCH 41
Crop height (cm)	12 – 14	15 - 18	18 – 20	18 – 20	20 – 25
Crop coverage (%)	10	10	25	25	25
Application Method	Spray	Spray	Spray	Spray	Spray
Application Placement	Foliar	Foliar	Foliar	Foliar	Foliar
Application equipment	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)	Oxford Precision Sprayer (Knapsack)
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	200	200	200	200
Temperature of air - shade (°C)	22.9	21.3	20.1	18.5	12.1
Relative humidity (%)	70.9	52.5	53.8	79.9	74.0
Wind speed range (m/s)	1.0 - 3.2	8.0 - 8.2	5.0 - 11.0	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	0.0% incidence	0.0% incidence	50.8% incidence

Disease assessment details

Disease assessments were carried out for 2 m row lengths within the central two rows of each plot. These individual 2 m row lengths were at least 0.5 m from plot ends, and marked using canes to ensure the same areas were assessed throughout the season. For the first two assessments, when the crop was lightly infected, a whole plot score was made for incidence (percent of plants infected) and severity (percent of leaf area affected), with a scale in increments of 5% used to record both. For the remaining three assessments, 20 onion plants were randomly sampled within the marked out area in each plot. The percent of symptomatic plants in this sample was recorded (incidence) and the degree of infection (severity) was recorded by assessing the percent of leaf area exhibiting downy mildew symptoms for each plant per sample, in increments of 5%. At the end of the trial, approximately twelve days before harvest, an independent disease assessment was conducted by Phil Langley recording the proportion of visible foliar downy mildew symptoms across each entire plot (% severity).

Evaluation date	Evaluation Timing (DA)*	Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotoxicity)	Assessment
05/09/19	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)
07/10/19	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 for the nine treatments and six replicates of the untreated control. Statistical analysis was carried out using ANOVA in Genstat 18.2, 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

No phytotoxic symptoms developed following the application of any test treatments at any assessment date. All products can be considered crop safe at the rates tested.

Efficacy

The first visible symptoms of downy mildew were observed in untreated plots 13 days after artificial inoculation, with 16.7% of untreated plants infected by the third assessment (30/09/19). The results for the mean percent of onion downy mildew incidence and severity, for assessments 3-5, 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.

No treatment reduced downy mildew disease incidence compared with the untreated control at any assessment date. However, all treatments, apart from AHDB9842 did have a significant ($p < 0.05$) effect on reducing the severity of downy mildew compared with the untreated control by the final assessment. Treatment with DP717 (applied in combination with the adjuvant Phase II) in particular resulted in the most significant reduction in downy mildew severity at the final two assessments, where downy mildew had become more prevalent in the crop (Table 4). By the final assessment treatment with DP717 resulted in 79.3% control of downy mildew compared to the untreated control, whilst the industry standard programme Amistar (azoxystrobin), Fubol Gold (mancozeb and metalaxyl-M), Infinito (fluopicolide and propamocarb hydrochloride) and Invader (dimethomorph & mancozeb) gave just under 65% control compared with the untreated (Figure 2).

AHDB9827 and AHDB9862 also performed well, significantly reducing downy mildew severity at the last two assessments. At the final assessment these provided 77.4% and 78.8% control respectively. The industry standard programme performed well as expected, comparable to AHDB9827, AHDB9862 and DP717 and no product provided significantly better control than the standard programme. The poorest performing product was AHDB9842 which gave no significant reduction in disease severity at any assessment date.

An independent assessment conducted by Phil Langley shortly before the trial was harvested confirmed the results recorded in this study (Figure 3).

Table 4. Effect of plant protection products on mean % onion downy mildew incidence for the final three assessment dates.

Date	30-Sep	07-Oct	25-Oct
Treatment			
Untreated	26.67	47.50	50.83
Standard	25.00	16.67	35.00
AHDB9842	36.67	38.33	35.00
AHDB9827	26.67	25.00	31.67
AHDB9941	31.67	33.33	41.67
AHDB9862	31.67	21.67	26.67
AHDB9911	31.67	36.67	41.67
AHDB9844	26.67	40.00	40.00
AHDB9823	31.67	28.33	36.67
DP717 + Phase II	26.67	13.33	15.00
P value	0.924	0.214	0.352
d.f.	21	21	21
s.e.d.	7.40	12.32	12.21
l.s.d.	15.38	25.62	25.39
	Significantly different from untreated control ($p > 0.05$)		
	Not significantly different from untreated control ($p > 0.05$)		

Table 5. Effect of plant protection products on mean % onion downy mildew severity for the final three assessment dates.

Date	30-Sep	07-Oct	25-Oct
Treatment			
Untreated	1.02	8.67	17.33
Standard	0.85	01.75	6.08
AHDB9842	0.70	12.50	12.17
AHDB9827	0.50	02.75	3.92
AHDB9941	0.72	04.75	7.33
AHDB9862	0.95	02.30	3.67
AHDB9911	0.95	07.83	9.50
AHDB9844	0.77	07.67	10.58
AHDB9823	0.95	06.58	9.00
DP717 + Phase II	0.50	0.62	3.58
P value	0.534	0.006	0.001
d.f.	21	21	21
s.e.d	0.20	2.46	2.90
l.s.d.	0.42	5.112	6.02
	Significantly different from untreated control (p>0.05)		
	Not significantly different from untreated control (p>0.05)		

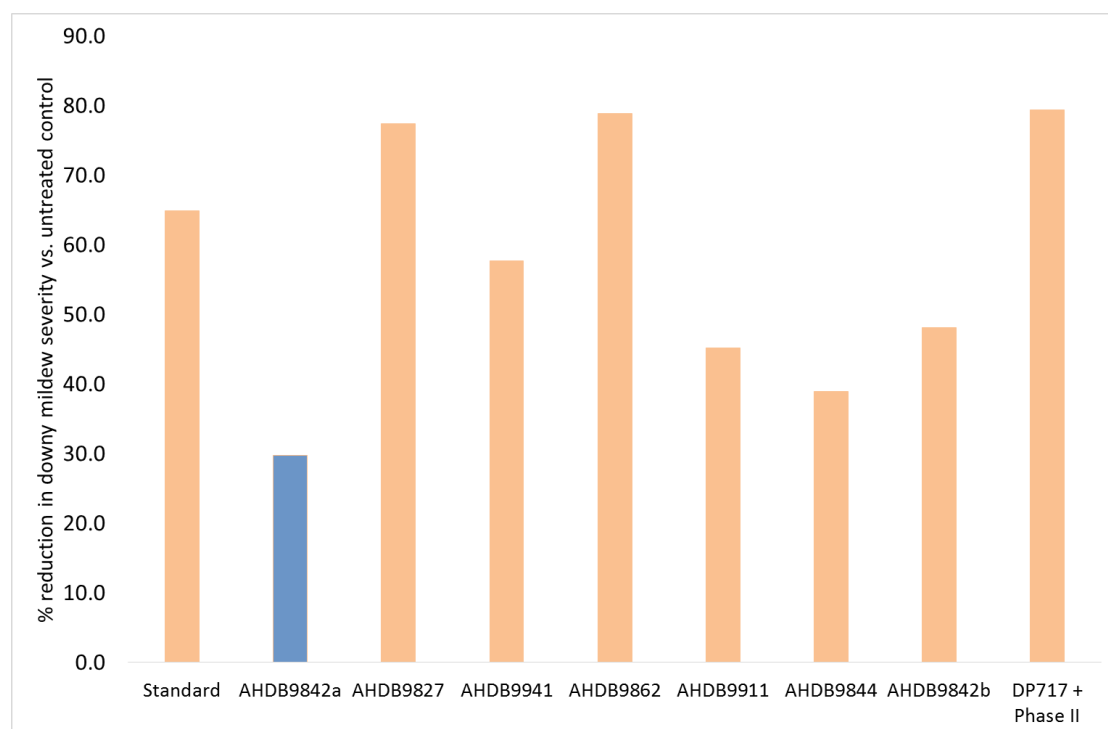


Figure 2. Degree of control of downy mildew severity (%) compared with the untreated control for the different plant protection products and industry standard programme, in field grown salad onion 22 days after the fifth treatment application (25.10.19). Orange bars represent significant reductions in downy mildew severity compared with the untreated control (P>0.05).

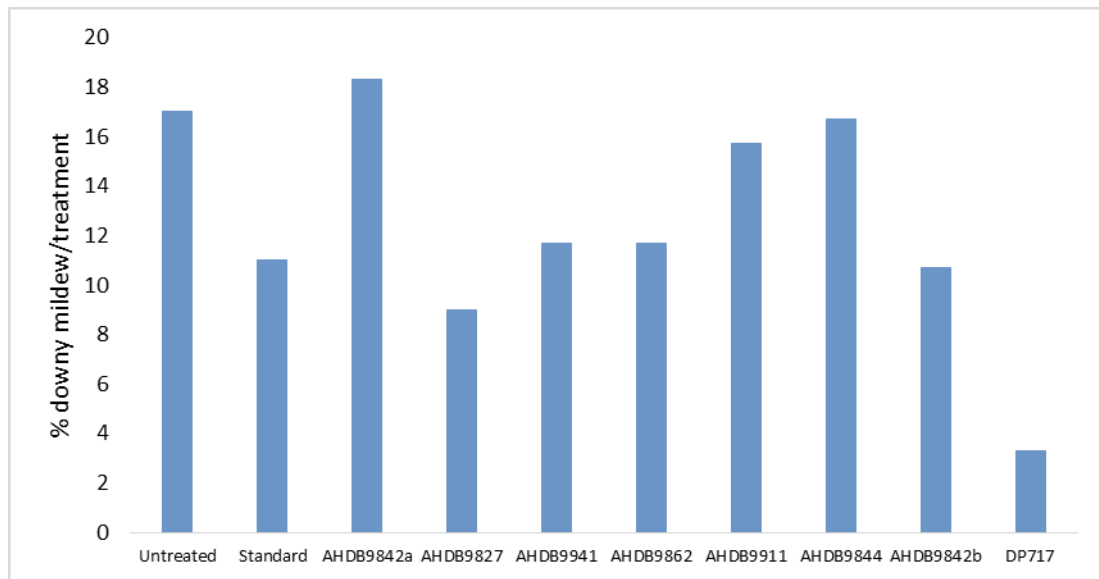


Figure 3. Effect of plant protection products, on mean downy mildew severity (proportion of visible foliar downy mildew symptoms across each plot) in field grown salad onion 47 days after the fifth treatment application - independent assessment conducted twelve days before harvest (18.11.19).

Discussion

As a consequence of low disease pressure the trial area was artificially inoculated with downy mildew using infector plants and disease levels developed to sufficient levels to observe statistically significant differences in reps 1-3.

No treatment was found to significantly reduce the incidence of downy mildew compared with the untreated control at any assessment date. With regard to severity, all products by the final assessment, apart from AHDB9842, gave significant control, with DP717 providing the greatest reductions at the final two assessments. AHDB9827 performed better than AHDB9844 and AHDB9823, despite these two products containing the same active as AHDB9827, but in combination with other fungicides and the reasons for this are unclear; the total amount of the shared active per hectare was less than that applied in AHDB9844 and 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.

DP717 gained an approval on salad onions in August 2019 for downy mildew control; thus this trial provides growers with confirmation of its efficacy. 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, DP717 and AHDB9862 provide three fungicide options with different modes of action which could be used to 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 (dimethomorph + mancozeb), a component of the industry standard programme used in this work, is currently the gold standard product for downy mildew control in salad onions; however the potential loss of mancozeb puts this product under threat.
- All products tested significantly reduced downy mildew severity by the final assessment, apart from AHDB9842 which provided no control at any assessment date.
- No product gave significant reductions in downy mildew incidence at any assessment date. This may be a consequence of artificial inoculation and differences in downy

mildew incidence may have developed in an uninoculated crop, under a greater disease pressure. Further work would be required to investigate this.

- A commercial standard treatment programme of Amistar (azoxystrobin), Fubol Gold (mancozeb & metalaxyl-M), Infinito (fluopicolide & propamocarb hydrochloride) and Invader provided good control of downy mildew severity.
- DP717 (plus the adjuvant Phase II), AHDB9862 and AHDB9827 all performed well in the trial and were effective in reducing both the severity of downy mildew in salad onions, comparable to the industry standard programme. 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.
- AHDB9827 performed better than AHDB9844 and AHDB9842 which both contain the same active ingredient as AHDB9827, in combination with other fungicides. The reasons for this are unclear.
- Further work should examine the best performing products from the trial as part of a fungicide programme 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 the final independent assessment on this trial.

Appendix

a. Crop diary – events related to growing crop.

Crop	Cultivar	Planting date
Salad onion	Yoda	08/07/2019

Fertilisers, herbicides and insecticides applied to the trial area.

Date	Product	Rate (L ha ⁻¹)
10/07/2019	Wing-P	1.300
	Stomp Aqua	0.300
	Toledo	0.500
	Crusade	0.400
	Touchdown Quattro	1.500
23/07/2019	Wing-P	0.700
	Cleancrop Amigo 2	0.700
27/07/2019	Cleancrop Amigo 2	1.000
	Stomp Aqua	0.400
02/08/2019	Cleancrop Gallifrey 3	0.125
12/08/2019	Buctril	0.400
20/08/2019	Buctril	0.400
23/08/2019	Centurion Max	1.750
27/08/2019	Crusade	0.400
	YaraVita Magflo 300	1.000
	New-Triton Manganese 15	1.000
	Tracer	0.200
03/09/2019	Crusade	0.400
	YaraVita Magflo	1.000
10/09/2019	Crusade	0.400
	YaraVita CropLift Pro	1.331
	Benevia	0.400
17/09/2019	Crusade	0.500
	YaraVita Magflo 300	1.000

b. Trial diary.

Date	Event
19/08/2019	Trial marked out and some plots hand weeded due to high weed pressure (volunteer WOSR). GS: BBCH13.
28/08/2019	Application A applied. GS: BBCH13.
05/09/2019	Application B applied & background disease assessment completed. AHDB9827 was applied at 150 g ha ⁻¹ instead of 200 g ha ⁻¹ . Trial hand weeded. GS: BBCH13.
17/09/2019	Application C applied & first full disease assessment completed. Trial hand weeded. GS: BBCH15.
25/09/2019	Application D applied. GS: BBCH19.
30/09/2019	Second full disease assessment completed. GS: BBCH19.
02/10/2019	Application E applied. GS: BBCH41.
07/10/2019	Third full disease assessment completed GS: BBCH41.
25/10/2019	Fourth full disease assessment completed. GS: BBCH43.
11/11/2019	Independent whole plot severity assessment completed. GS: BBCH49.

c. Table showing readings from Burkhard spore trap used confirm presence of *P. destructor* - supplied by Phil Langley, G's Fresh.

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

d. Trial images



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



Typical downy mildew symptoms in the untreated control plots, at the final assessment date – 25.10.2019.

e. 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	78.2	12.1
20/08/2019	8.5	22.5	74.6	10.4
21/08/2019	7.5	25.0	73.6	10.9
22/08/2019	8.5	25.5	73.1	11.9
23/08/2019	10.5	28.0	72.8	13.3
24/08/2019	9.0	30.5	74.4	13.5
25/08/2019	12.0	33.0	72.8	15.7
26/08/2019	12.5	32.0	73.6	15.7
27/08/2019	14.0	32.5	75.0	16.9
28/08/2019	17.0	25.5	77.9	15.6
29/08/2019	10.5	25.0	74.8	12.9
30/08/2019	10.5	25.5	77.4	12.9
31/08/2019	10.0	24.5	79.0	11.8
01/09/2019	9.0	22.5	73.7	9.7
02/09/2019	5.5	25.0	75.0	9.6
03/09/2019	13.5	20.5	76.1	12.3
04/09/2019	12.5	20.0	75.9	11.9
05/09/2019	8.0	19.5	72.0	8.2
06/09/2019	5.0	18.0	81.6	9.0
07/09/2019	7.5	19.0	80.3	9.6
08/09/2019	4.0	20.0	77.1	7.2
09/09/2019	10.5	15.5	88.8	10.8
10/09/2019	8.0	24.0	83.8	11.2
11/09/2019	11.5	23.0	84.6	13.7
12/09/2019	11.0	28.5	85.9	15.0
13/09/2019	12.0	26.0	79.5	13.8
14/09/2019	7.0	27.0	81.9	12.3
15/09/2019	7.0	29.0	82.4	13.1
16/09/2019	13.0	23.0	87.4	14.9
17/09/2019	10.5	24.0	72.9	11.6
18/09/2019	9.0	23.5	51.5	6.1
19/09/2019	8.5	18.5	56.0	5.4
20/09/2019	12.5	17.5	65.6	8.6
21/09/2019	13.0	19.0	65.1	9.2
22/09/2019	16.0	20.0	68.1	11.8
23/09/2019	15.5	19.0	68.6	11.3
24/09/2019	16.5	18.0	73.1	12.3
25/09/2019	15.5	18.0	74.4	11.9
26/09/2019	15.5	17.0	72.2	11.9
27/09/2019	14.5	16.5	71.6	10.5
28/09/2019	13.0	18.0	73.1	10.0
29/09/2019	15.0	16.0	76.4	12.0
30/09/2019	12.0	16.5	75.0	9.9
01/10/2019	14.0	13.5	77.2	11.2
02/10/2019	9.0	11.5	69.5	5.8
03/10/2019	7.5	13.5	70.7	4.5
04/10/2019	11.0	14.5	76.3	8.1
05/10/2019	12.0	13.5	75.5	9.1
06/10/2019	12.5	12.5	77.4	9.0
07/10/2019	10.0	14.0	78.5	7.7
08/10/2019	11.5	13.0	79.3	9.2
09/10/2019	10.5	13.0	76.4	7.7
10/10/2019	9.5	15.5	76.5	7.4
11/10/2019	13.5	14.5	80.2	11.0
12/10/2019	12.5	14.0	78.9	9.6
13/10/2019	11.5	12.5	80.4	9.3
14/10/2019	11.0	13.0	80.4	8.4
15/10/2019	12.0	13.0	81.3	9.4
16/10/2019	10.5	11.5	81.2	8.7
17/10/2019	8.5	12.0	80.3	6.9
18/10/2019	10.5	12.0	81.1	7.9
19/10/2019	9.5	11.0	80.6	7.5

Date	Min Temp (°C)	Max Temp (°C)	Average RH (%)	Average Dew Point (°C)
20/10/2019	8.0	11.5	79.6	6.4
21/10/2019	10.0	11.0	81.7	7.7
22/10/2019	9.0	10.5	80.8	6.9
23/10/2019	7.0	11.5	80.3	5.8
24/10/2019	10.5	12.5	82.2	8.2
25/10/2019	9.0	12.5	82.9	7.7

f. Raw assessment data:

i. Onion downy mildew incidence and severity results (plot averages) for the five full disease assessments – ADAS.

Plot No	Assessment Date Assessment Type Treatment Name	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
		Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
109	Untreated	5	0.68	10	0.45	15	0.45	55	16.50	60	25.00
207	Untreated	5	0.76	10	0.80	20	0.80	45	5.75	40	16.00
309	Untreated	10	0.40	15	0.85	25	0.85	40	7.50	50	17.00
408	Untreated	15	0.68	20	1.05	25	1.05	5	1.00	20	9.00
502	Untreated	15	0.52	20	0.90	20	0.90	0	0.00	0	0.00
107	Untreated	10	0.52	15	0.25	15	0.25	40	6.50	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	1.60	50	1.60	45	6.00	55	14.00
407	Untreated	60	0.40	65	3.25	75	3.25	5	1.00	15	2.25
503	Untreated	35	0.48	45	1.15	55	1.15	0	0.00	0	0.00
105	Standard	5	0.48	10	0.30	10	0.30	15	1.00	35	6.50
210	Standard	25	0.92	30	1.10	30	1.10	35	4.25	45	6.25
311	Standard	20	0.92	25	1.15	35	1.15	0	0.00	25	5.50
409	Standard	20	0.56	25	0.85	25	0.85	0	0.00	5	0.50
504	Standard	20	0.48	25	1.00	30	1.00	0	0.00	0	0.00
104	AHDB9842	30	0.60	35	0.70	40	0.70	60	14.00	45	10.00
203	AHDB9842	15	0.72	20	0.50	20	0.50	40	16.50	45	20.00
302	AHDB9842	40	0.56	45	0.90	50	0.90	15	7.00	15	6.50
405	AHDB9842	25	0.32	30	0.95	35	0.95	0	0.00	0	0.00
511	AHDB9842	45	0.32	50	1.75	55	1.75	0	0.00	0	0.00
108	DP717	5	0.72	10	0.40	20	0.40	15	1.00	25	2.25
206	DP717	20	0.36	25	0.50	30	0.50	50	6.25	55	7.75
305	DP717	15	0.44	25	0.60	30	0.60	10	1.00	15	1.75
403	DP717	15	0.44	15	0.75	25	0.75	0	0.00	5	0.50
501	DP717	15	0.36	20	0.85	25	0.85	0	0.00	0	0.00
103	AHDB9941	10	0.76	15	0.50	20	0.50	80	6.00	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	1.00	40	1.00	10	7.00	15	9.50

Plot No	Assessment Date Assessment Type Treatment Name	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
		Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)	Incidence (%)	Severity (%)
410	AHDB9941	20	0.64	20	0.90	30	0.90	0	0.00	15	1.00
508	AHDB9941	30	0.28	35	1.55	45	1.55	0	0.00	0	0.00
111	AHDB9862	15	0.44	25	0.90	30	0.90	15	0.90	20	2.75
205	AHDB9862	10	0.76	10	0.60	20	0.60	50	6.00	50	7.00
307	AHDB9862	25	0.52	30	1.35	45	1.35	5	0.00	10	1.25
404	AHDB9862	30	0.28	40	0.95	45	0.95	0	0.00	0	0.00
510	AHDB9862	25	0.56	30	1.15	35	1.15	0	0.00	0	0.00
101	AHDB9911	30	0.32	35	1.05	45	1.05	0	14.00	30	13.50
209	AHDB9911	15	0.16	15	0.45	25	0.45	30	16.50	55	25.00
301	AHDB9911	20	0.60	25	1.05	25	1.05	50	3.25	40	6.50
406	AHDB9911	30	0.44	35	1.40	40	1.40	30	1.00	5	1.00
509	AHDB9911	20	0.40	30	0.85	35	0.85	5	0.00	0	0.00
110	AHDB9844	10	1.16	15	0.70	20	0.70	0	13.00	60	20.50
202	AHDB9844	25	0.40	30	0.45	35	0.45	65	4.50	30	6.00
310	AHDB9844	15	0.68	15	1.15	25	1.15	25	5.50	30	5.25
402	AHDB9844	35	0.52	40	0.95	45	0.95	30	0.00	0	0.00
507	AHDB9844	50	0.44	55	1.80	60	1.80	0	0.00	0	0.00
102	AHDBXXXX	10	0.40	15	0.40	20	0.40	0	10.25	30	13.50
211	AHDBXXXX	25	0.56	30	1.20	30	1.20	25	8.50	60	9.75
306	AHDBXXXX	40	0.24	45	1.25	45	1.25	50	1.00	20	3.75
411	AHDBXXXX	35	0.32	40	1.35	45	1.35	10	0.00	0	0.00
505	AHDBXXXX	35	0.28	40	10.00	45	1.00	0	0.00	0	0.00
106	AHBD9841	0	0.68	5	0.75	10	0.75	0	1.15	20	4.75
204	AHBD9841	30	0.60	30	1.35	35	1.35	20	0.70	25	6.00
304	AHBD9841	25	0.80	30	0.95	35	0.95	20	0.00	0	0.00
401	AHBD9841	35	0.72	45	1.10	50	1.10	0	1.00	5	1.00
506	AHBD9841	25	0.60	50	1.50	60	1.50	5	0.00	0	0.00

ii. Onion downy mildew severity results (plot averages, reps 1-3) for the Independent assessment (Phil Langley, G's) - 11/11/2019.

Plot No	Treatment Name	Severity (%)
109	Untreated	20
207	Untreated	25
309	Untreated	12
107	Untreated	15
208	Untreated	15
303	Untreated	15
105	Standard	20
210	Standard	10
311	Standard	3
104	AHDB9842	30
203	AHDB9842	15
302	AHDB9842	10
108	DP717	5
206	DP717	15
305	DP717	7
103	AHDB9941	20
201	AHDB9941	5
308	AHDB9941	10
111	AHDB9862	15
205	AHDB9862	15
307	AHDB9862	5
101	AHDB9911	10
209	AHDB9911	30
301	AHDB9911	7
110	AHDB9844	20
202	AHDB9844	15
310	AHDB9844	15
102	AHDB9842	15
211	AHDB9842	12
306	AHDB9842	5
106	AHBD9841	3
204	AHBD9841	5
304	AHBD9841	2

h. ORETO certification



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