

# CP 205 AHDB Horticulture Efficacy Trials 2022

## Final Trial Report

<b>Work package:</b>	WP1
<b>Title:</b>	Bean seed fly ( <i>Delia</i> spp.) control in alliums
<b>Crop</b>	Leek and salad onion
<b>Target</b>	Bean seed fly ( <i>Delia platura</i> & <i>Delia florilega</i> )
<b>Lead researcher:</b>	Prof Rosemary Collier
<b>Organisation:</b>	University of Warwick
<b>Period:</b>	April – November 2022
<b>Report date:</b>	16/1/2023
<b>Report authors:</b>	Andrew Jukes and Prof Rosemary Collier
<b>ORETO Number: (certificate should be attached)</b>	381

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: 28 February 2023    Author's signature:



# Trial Summary

## Introduction

Bean seed fly (*Delia platura*) affects more than 40 different host plants. Hosts include Phaseolus beans, peas, broad beans, cucumber, melon, onion, pepper, potato, maize. The bean seed fly larva is a common pest found in most temperate countries. In severe infestations plant loss at seedling stage may be high, often resulting in re-drilling and subsequent loss of production of high value vegetable crops at an early growth stage. Adult flies are attracted to freshly disturbed soil containing debris from previous crops, high levels of organic matter such as farmyard manure, or weed debris. Eggs are laid on the soil surface and larvae hatch after a few days and feed on newly planted seeds or plant and crop debris. After 10-14 days, larvae pupate and emerge as a further generation of flies, which move to suitable feeding sites. There may be several overlapping generations per year, occurring from spring until early autumn.

There is currently limited chemical control for bean seed fly larvae or adults and, after the removal of seed treatment options for alliums after 2022 the problem is likely to increase. Alliums sown around the peak of bean seed fly emergence in the spring (April to May) are particularly at risk and some growers are experiencing high losses at establishment.

## Methods

Two trials were conducted, both on drilled alliums.

### *Trial on leeks at Wellesbourne*

Leek seeds were drilled at Warwick Crop Centre, Wellesbourne, Warwickshire on 21 April 2022 after the soil had been augmented with cow manure to increase the organic content and attract bean seed flies. Treatments were applied as either granules in-furrow or sprays along the rows immediately post drilling. Treatments were washed down with irrigation, for an hour immediately after spraying. Seedling mortality due to bean seed fly was assessed by counting seedlings 32 and 40 days after drilling when the majority of the seedlings were at the 011 - 012 growth stage. Samples of leek plants were taken on 7 November from three treatments and dispatched to Eurofins, Wolverhampton for residue analysis.

### *Trial on salad onions at in commercial crop at Milcote, Warwickshire*

This trial was undertaken in a commercial crop of salad onions at Milcote, Warwickshire. Prior to drilling, on 10 May, the trial area was cultivated with a bed-former. On 18 May, salad onion seed (no Force ST seed treatment) was drilled using an Agricola precision drill at a rate of 60 seeds/m with 6 rows per bed. Granular treatments were applied in-furrow at drilling, to the central two rows per plot

using a tractor mounted precision granule applicator. As all three granule treatments had to be applied simultaneously, a single dose of 16 kg/ha had to be chosen. The remainder of the field was drilled with Force ST treated seed.

After drilling, the remaining treatments were applied as ground sprays along individual rows using a knapsack sprayer. Irrigation (30 minutes) was applied immediately after spraying. The Hallmark treatment was re-applied on 24 May (one week after drilling) and was followed by a period of heavy rain.

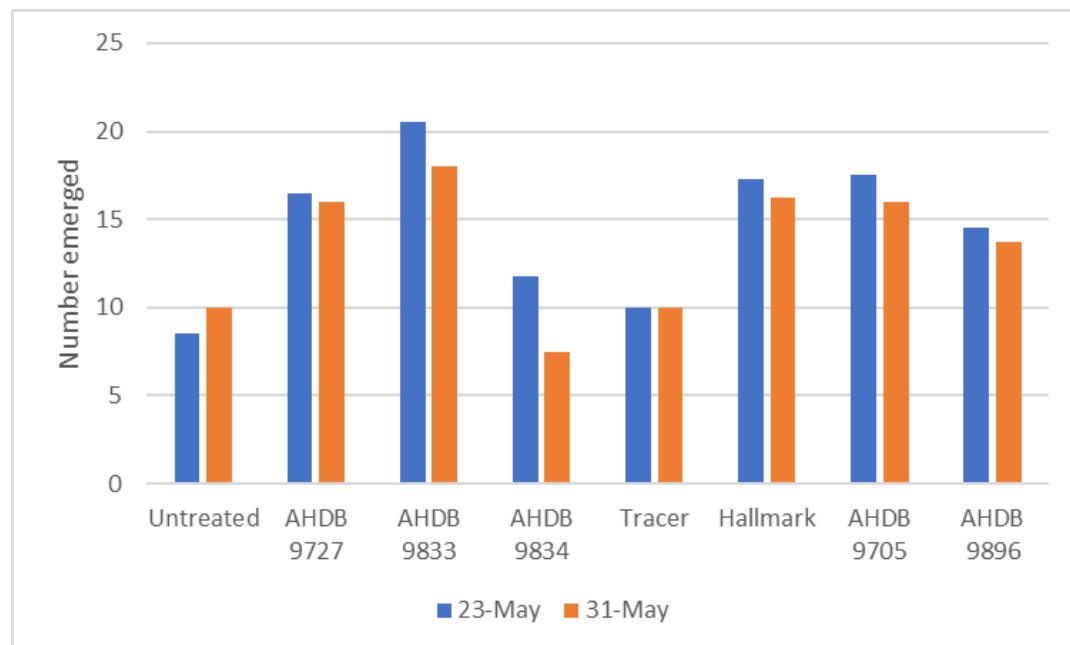
Emergence counts were carried out on 15 June and 13 July by recording the number of plants in the whole 3m length in the central two rows in each plot. For comparison a sub-sample of seedlings from Force ST treated seed were also counted.

## Results

### *Trial on leeks at Wellesbourne*

The mean number of plants emerged in control plots was 8.5 on 23 May rising to 10 on 31 May which represented 4% of the total number drilled (240 seeds per plot). None of the treatments successfully controlled damage and there were no significant ( $p < 0.05$ ) differences between treatments when considering emergence (Figure A).

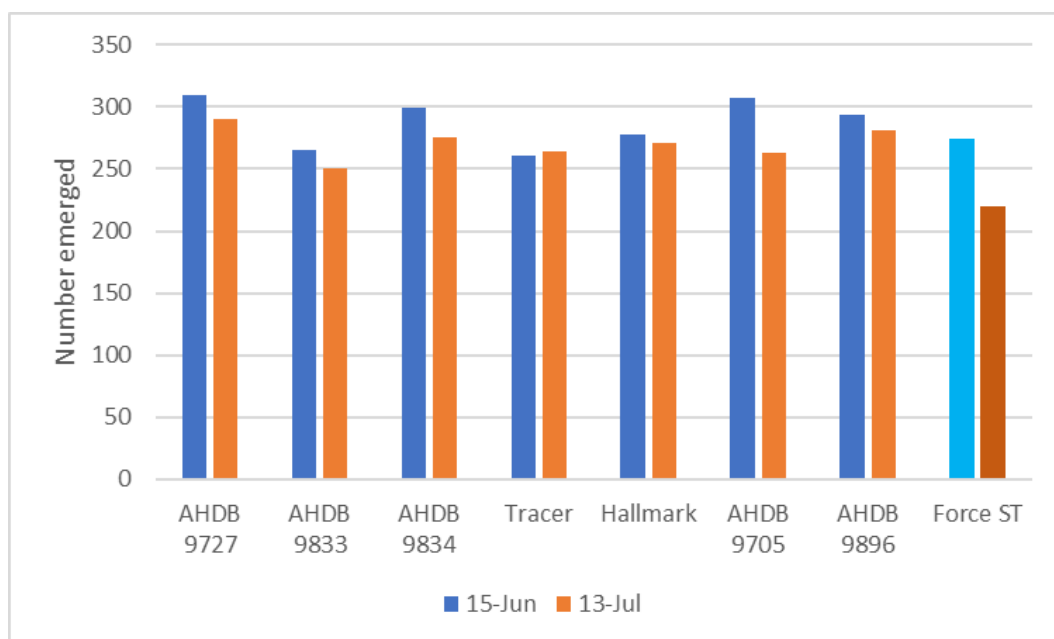
No insecticide residues were detected in treatments 1 (untreated), 2 (AHDB 9727) or 3 (AHDB 9833) by Eurofins, Wolverhampton using analysis suite PUD4U-2 (HPLC-MS and GC-MS).



**Figure A** Mean number of leeks emerged per plot out of 240 seeds drilled (5m x 4 rows) at Warwick Crop Centre in 2022.

*Trial on salad onions at in commercial crop at Milcote, Warwickshire*

There was no evidence of phytotoxicity with any treatment. There were low levels of damage from bean seed fly larvae in the salad onion trial drilled at Milcote. The mean number of plants which emerged in control plots was 286 on 15 June falling to 255 on 13 July which represented 79% and 71% respectively of the total number drilled (360 seeds per plot). AHDB 9727 yielded the highest seedling counts on both assessment dates but there were no significant ( $p < 0.05$ ) differences between treatments when considering emergence (Figure B). There was little difference between the untreated control and Force ST seed treatment assessed in adjacent beds.



**Figure B** Mean number of salad onions emerged per plot out of 360 seeds drilled (3m x 2 rows) at Milcote in 2022.

**Take home message:**

Damage to the leek trial at Warwick Crop Centre showed that in the presence of a severe infestation of bean seed fly larvae all potential treatments were overcome. In contrast, the salad onion trial conducted within a commercial crop at Milcote had insufficient damage due to bean seed fly to discriminate between treatments. Parallel trials on green beans in 2022 were similarly overwhelmed by bean seed fly and thus there is still further work to do to confirm whether any of the treatments will provide control of bean seed fly at lower levels on infestation.



# SCIENCE SECTION

## Objectives

## Methods

### 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 1/135	Phytotoxicity assessment	
PP 1/152	Design and analysis of efficacy evaluation trials	
PP 1/223	Introduction to the efficacy evaluation of plant protection products	
PP 1/34	Delia platura and Delia florilega	

### Trial 1

#### Test site

Item	Details
Location address	Warwick Crop Centre, Wellesbourne Campus, University of Warwick, Wellesbourne, Warwick, CV35 9EF. Latitude 52 12 18 N Longitude 1 36 00 W
Crop	Leek
Cultivar	Jolant
Soil or substrate type	Sandy-loam soil P:K:Mg 4:3:2 pH 6.5 Organic matter (LOI) 3.7 % (after organic augmentation)
Agronomic practice	See appendix
Prior history of site	2021 - fallow

#### Trial design

Item	Details
Trial design:	(4x4)/2 Trojan Square
Number of replicates:	4
Row spacing:	35 cm
Plot size: (w x l)	1.83 x 5 m
Plot size: (m <sup>2</sup> )	9.2
Number of plants per plot:	240
Leaf Wall Area calculations	n/a

## Treatment details

AHDB Code	Active substance	Product name/ manufacturer code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
	Untreated					
AHDB 9727	N/D	N/D	N/D	N/D	N/D	None
AHDB 9833	N/D	N/D	N/D	N/D	N/D	None
AHDB 9834	N/D	N/D	N/D	N/D	N/D	None
Tracer	Spinosad	Tracer	D074276100	480 g/l	SC	None
Hallmark Zeon	Lambda cyhalothrin	Hallmark Zeon	BSW00F0670	100 g/l	CS	None
AHDB 9705	N/D	N/D	N/D	N/D	N/D	None
AHDB 9896	N/D	N/D	N/D	N/D	N/D	None

## 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
2	AHDB 9727	N/D	N/D	A
3	AHDB 9833	N/D	N/D	B
4	AHDB 9834	N/D	N/D	B
5	Tracer	96 g/ha	0.2 l/ha	B
6	Hallmark Zeon	7.5 g/ha	0.075 l/ha	B C
7	AHDB 9705	N/D	N/D	B
8	AHDB 9896	N/D	N/D	A

## Application details

	Application A	Application B	Application C
Application date	21/4/22	21/4/22	28/4/22
Time of day	11.00	14.00	11.00
Crop growth stage (Max, min average BBCH)	n/a	n/a	n/a
Crop height (cm)	n/a	n/a	n/a
Crop coverage (%)	n/a	n/a	n/a
Application Method	Granule	Spray	
Application Placement	In-furrow	Soil surface	
Application equipment	Custom applicator	Berthoud Vermorel 2000HP	
Nozzle pressure	n/a	2 bar	
Nozzle type	n/a	05F110	
Nozzle size	n/a	05	
Application water volume/ha		1000	
Temperature of air - shade (°C)	16	17	11
Relative humidity (%)	72	72	75
Wind speed range (m/s)	Not recorded	Not recorded	Not recorded
Dew presence (Y/N)	n/a	n/a	n/a
Temperature of soil - 2-5 cm (°C)	Not recorded	Not recorded	Not recorded
Wetness of soil - 2-5 cm	Damp	Damp	Damp
Cloud cover (%)	Not recorded	Not recorded	Not recorded

## 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
Bean seed fly	<i>Delia platura</i> <i>Delia florilega</i>	HYLEPL HYLEFG	Not known		

## Method details

Organic matter (partially rotted cow manure plus straw) was added to the trial area at a rate of approximately 40 t/ha on 7 April. Prior to drilling, on 20 April, the trial area was cultivated with a bed-former. On the day after cultivation (21 April) granular treatments were applied in-furrow using a custom-made seed drill fitted with a belt driven granule applicator. Leek (variety Jolant) seed was drilled through the previously applied granule bands and into granule-free plots using an Agricola precision drill at a rate of 12 seeds/m with 4 rows per bed.



After drilling, the remaining treatments were applied as ground sprays along individual rows using a knapsack sprayer fitted with a single 05F110 nozzle, operating at a pressure of 2 bar for a fine/medium droplet quality. Water volume was 1000 l/ha for all spray products. Irrigation (30 minutes) was applied immediately after spraying. To further increase attractiveness of the trial to bean seed fly, blood, fish and bone was added at 70g/m<sup>2</sup>. The Hallmark treatment was re-applied on 28 April (one week after drilling).

Emergence counts were carried out on 23 May and 31 May by recording the number of plants in the whole 5 m length in all four rows in each plot.

Samples (5 leeks per plot, 20 leeks per treatment) were taken on 7 November from treatments 1 (untreated), 2 (AHDB 9727) and 3 (AHDB 9833), trimmed, washed, chilled and dispatched to Eurofins, Wolverhampton for residue analysis.

### Assessment details

Evaluation date	Evaluation Timing (DA)*		Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotoxicity)	Assessment
	After first conventional insecticides	After first bio-pesticides			
23/5/22	32	32	011	Efficacy	Seedling count
23/5/22	32	32	011	Phytotoxicity	Leaf damage
31/5/22	40	40	012	Efficacy	Seedling count
7/11/22	199	199	409	Residues	HPLC and GC analysis

\* DA – days after application

### Statistical analysis

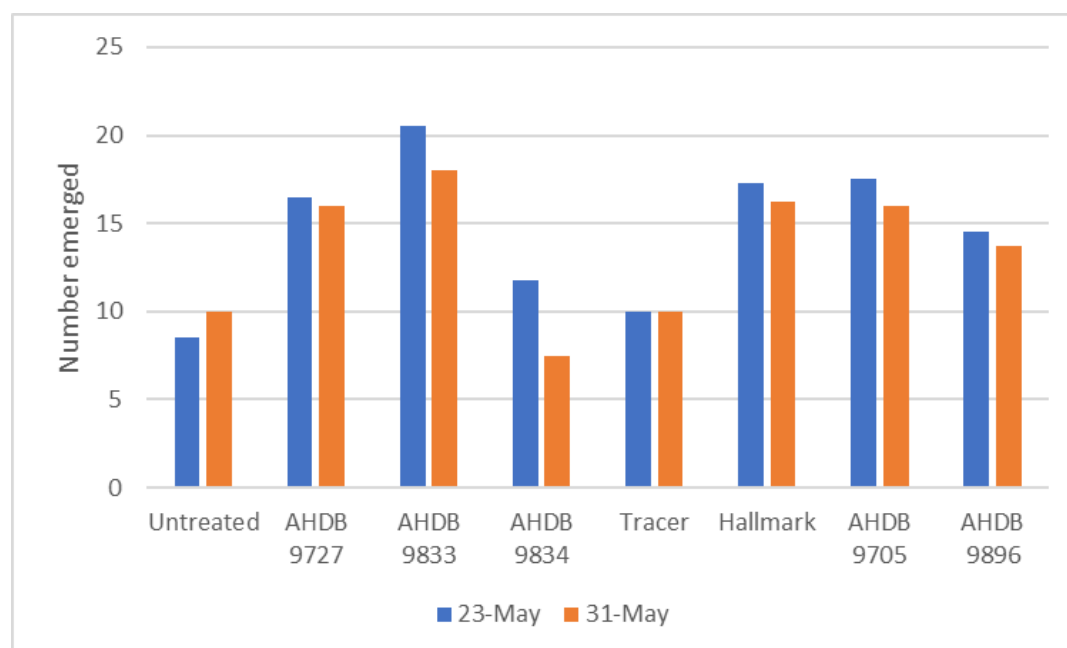
This trial was designed as a Trojan square for 8 treatments in a (4\*4)/2 design. The number seedlings per plot (2 assessments) were analysed by ANOVA using the Excel data package. The analyses were interpreted using treatment means together with standard errors for the differences (SED) between means and associated 5% least significant differences (LSD). In all cases plot totals were used.

### Results

There was no evidence of phytotoxicity with any treatment. There were very high levels of damage from bean seed fly larvae in the leek trial drilled at Warwick Crop Centre. The mean number of plants emerged in control plots was 8.5 on 23 May rising to 10 on 31 May which represented 4% of the total number drilled (240 seeds per plot). None of the treatments successfully controlled damage and there were no significant ( $p < 0.05$ ) differences between treatments (Table 1 and Figure 1) when considering emergence.

**Table 1** Mean number of leeks emerged per plot out of 240 seeds drilled on 23 May and 31 May at Warwick Crop Centre in 2022.

Treatment	Number emerged per plot	
	23 May	31 May
Untreated	8.5	10
AHDB 9727	16.5	16
AHDB 9833	20.5	18
AHDB 9834	11.8	7.5
Tracer	10.0	10
Hallmark Zeon	17.3	16.3
AHDB 9705	17.5	16.0
AHDB 9896	14.5	13.8
F-value	0.623	0.617
P-value	0.732	0.737
SED	7.43	6.84
5% LSD	15.33	14.11
df	24	24



**Figure 1** Mean number of leeks emerged per plot out of 240 seeds drilled (5m x 4 rows) at Warwick Crop Centre in 2022.

### Insecticide residues

No insecticide residues were detected in samples sent for testing which were taken from treatments 1 (untreated), 2 (AHDB 9727) or 3 (AHDB 9833) (by Eurofins, Wolverhampton using analysis suite PUD4U-2 (HPLC-MS and GC-MS)).

### Trial 2

## Test site

Item	Details
Location address	G's Fresh, Milcote, Stratford-upon-Avon, Wawickshire Latitude 52 09 52 N Longitude 1 44 57 W
Crop	Salad onion
Cultivar	Totem
Soil or substrate type	Sandy-loam soil P:K:Mg 4:2:-1+ pH 6.8 Organic matter (LOI) not measured (<5 %)
Agronomic practice	See appendix
Prior history of site	Not known

## Trial design

Item	Details
Trial design:	Randomised block
Number of replicates:	4
Row spacing:	25 cm
Plot size: (w x l)	1.83 x 10 m
Plot size: (m <sup>2</sup> )	18.3
Number of plants per plot:	3600
<i>Leaf Wall Area calculations</i>	n/a

\*

## Treatment details

AHDB Code	Active substance	Product name/ manufacturer code	Formulation batch number	Content of active substance in product	Formulation type	Adjuvant
	Untreated					
AHDB 9727	N/D	N/D	N/D	N/D	GR	None
AHDB 9833	N/D	N/D	N/D	N/D	GR	None
AHDB 9834	N/D	N/D	N/D	N/D	SC	None
Tracer	Spinosad	Tracer	D074276100	480 g/l	SC	None
Hallmark Zeon	Lambda cyhalothrin	Hallmark Zeon	BSW00F0670	100 g/l	CS	None
AHDB 9705	N/D	N/D	N/D	N/D	n/a	None
AHDB 9896	N/D	N/D	N/D	N/D	GR	None

## 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
2	AHDB 9727	N/D	N/D	A
3	AHDB 9833	N/D	N/D	B
4	AHDB 9834	N/D	N/D	B
5	Tracer	96 g/ha	0.2 l/ha	B
6	Hallmark Zeon	7.5 g/ha	0.075 l/ha	B C
7	AHDB 9705	N/D	N/D	B
8	AHDB 9896	N/D	N/D	A

<sup>1</sup> Recommended rate 15 kg/ha

<sup>2</sup> Recommended rate 20 kg/ha

### Application details

	Application A	Application B	Application C
Application date	18/5/22	18/5/22	24/5/22
Time of day	14.00	16.00	11.00
Crop growth stage (Max, min average BBCH)	n/a	n/a	n/a
Crop height (cm)	n/a	n/a	n/a
Crop coverage (%)	n/a	n/a	n/a
Application Method	Granule	Spray	
Application Placement	In-furrow	Soil surface	
Application equipment	Horstine applicator	Berthoud Vermorel 2000HP	
Nozzle pressure	n/a	2 bar	
Nozzle type	n/a	05F110	
Nozzle size	n/a	05	
Application water volume/ha		1000	
Temperature of air - shade (°C)	19	18	15
Relative humidity (%)	78	78	77
Wind speed range (m/s)	Not recorded	Not recorded	Not recorded
Dew presence (Y/N)	n/a	n/a	n/a
Temperature of soil - 2-5 cm (°C)	Not recorded	Not recorded	Not recorded
Wetness of soil - 2-5 cm	Damp	Damp	Damp
Cloud cover (%)	Not recorded	Not recorded	Not recorded

**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
Bean seed fly	<i>Delia platura</i> <i>Delia florilega</i>	HYLEPL HYLEFG	Not known		

## Method details

Prior to drilling, on 10 May, the trial area was cultivated with a bed-former. On 18 May, salad onion (variety Totem) seed was drilled using an Agricola precision drill at a rate of 60 seeds/m with 6 rows per bed. The seed drilled in trial plots was not treated with Force ST (tefluthrin). Granular treatments were applied in-furrow at drilling, to the central two rows per plot using a tractor mounted precision granule applicator. As all three granule treatments had to be applied simultaneously, a single dose of 16 kg/ha had to be chosen. The remainder of the field was drilled with Force ST treated seed.

After drilling, the remaining treatments were applied as ground sprays along individual rows using a knapsack sprayer fitted with a single 05F110 nozzle, operating at a pressure of 2 bar for a fine/medium droplet quality. Water volume was 1000 l/ha for all spray products. Irrigation (30 minutes) was applied immediately after spraying. The Hallmark treatment was re-applied on 24 May (one week after drilling) and was followed by a period of heavy rain.

Emergence counts were carried out on 15 June and 13 July by recording the number of plants in the whole 3m length in the central two rows in each plot. For comparison a sub-sample of seedlings from Force ST treated seed were also counted.

## Assessment details

Evaluation date	Evaluation Timing (DA)*		Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotoxicity)	Assessment
	After first conventional insecticides	After first bio-pesticides			
15/6/22	28	28	011	Efficacy	Seedling count
15/6/22	28	28	011	Phytotoxicity	Leaf damage
13/7/22	56	56	101	Efficacy	Seedling count

\* DA – days after application

## Statistical analysis

This trial was designed as a randomized block for 9 treatments, two of which were untreated controls. The number seedlings per plot (2 assessments) were analysed by ANOVA using the Excel data package. The analyses were interpreted using treatment means together with standard errors for the differences (SED) between

means and associated 5% least significant differences (LSD). In all cases plot totals were used.

## Results

There was no evidence of phytotoxicity with any treatment. There were low levels of damage from bean seed fly larvae in the salad onion trial drilled at Milcote. The mean number of plants emerged in control plots was 286 on 15 June falling to 255 on 13 July which represented 79% and 71% respectively of the total number drilled (360 seeds). AHDB 9727 yielded the highest seedling counts on both assessment dates but there were no significant ( $p < 0.05$ ) differences between treatments (Table 2 and Figure 2) when considering emergence. There was little difference between the untreated control and Force ST seed treatment assessed in adjacent beds.

**Table 2** Mean number of salad onions emerged per plot out of 360 seeds drilled on 15 June and 13 July at Milcote in 2022 .

Treatment	Number emerged per plot	
	15 June	13 July
Untreated	286	255
AHDB 9727	310	291
AHDB 9833	265	250
AHDB 9834	299	276
Tracer	260	264
Hallmark Zeon	278	271
AHDB 9705	308	264
AHDB 9896	294	282
Force ST <sup>1</sup>	274	220
F-value	0.726	0.514
P-value	0.652	0.816
SED	27.75	20.00
5% LSD	44.55	40.97
df	28	28

<sup>1</sup> Not included in analysis



**Figure 2** Mean number of salad onions emerged per plot out of 360 seeds drilled (3m x 2 rows) at Milcote in 2022.

## Discussion

Damage to the leek trial at Warwick Crop Centre showed that in the presence of a severe infestation of bean seed fly larvae all potential treatments were overcome. In contrast, the salad onion trial conducted within a commercial crop at Milcote had insufficient damage due to bean seed fly to discriminate between treatments. Parallel trials on green beans in 2022 were similarly overwhelmed by bean seed fly and thus there is still further work to do to confirm whether any of the treatments will provide control of bean seed fly at lower levels on infestation.

Damage to the leek trial at Warwick Crop Centre also appears to confirm that recent incorporation of organic matter and cultivation are likely to increase the incidence of bean seed fly larvae.

## Conclusions

There is still further work to do to confirm whether any of the treatments tested will provide control of bean seed fly at lower levels on infestation.

## Acknowledgements

We are very grateful to the AHDB for funding these trials and to Kim Parker in particular for all her support for them. We are also extremely grateful to G's for

hosting the salad onion trial at Milcote. We would also like to thank the crop protection companies for the supply of products for testing.

## **References**

There are presentations relating to this work on the University of Warwick web site: [Bean seed fly meeting 2023 \(warwick.ac.uk\)](#).



## Appendix

### a. Trial diary

#### Trial 1 – Leek Warwick Crop Centre

Date	Notes
16/09/2022	Applied 0.20.30 @ 200 kg/ha
07/03/2022	Subsoiled
08/03/2022	Ploughed
07/04/2022	Organic matter (cow manure + straw) spread at 40t/ha
20/04/2022	Applied Nitrogen @ 100 kg/ha
20/04/2022	Bed-formed
21/04/2022	Applied granular treatments in-furrow before drilling
21/04/2022	Drilled leeks -. 4 rows per bed @ 35 cm with 12 seeds/m in the row
21/04/2022	Set fencing and irrigation
21/04/2022	Spray treatments applied along rows
21/04/2022	Irrigated for 1 hour
22/04/2022	Sprayed Stomp Aqua @ 2.9 l/ha
22/04/2022	Applied Blood, Fish and Bone @ 3.125 kg/bed
28/04/2022	Second Hallmark spray applied
29/04/2022	Irrigated for 1 hour
06/05/2022	Irrigated for 30 mins
09/05/2022	Irrigated for 30 mins
30/05/2022	Irrigated for 30 mins
10/06/2022	Hand weeded
13/06/2022	Hand weeded
17/06/2022	Irrigated for 30 mins
24/06/2022	Irrigated for 30 mins
01/07/2022	Hand weeded
08/07/2022	Irrigated for 30 mins
13/07/2022	Irrigated for 30 mins
15/07/2022	Irrigated for 30 mins
18/07/2022	Irrigated for 30 mins
20/07/2022	Irrigated for 30 mins
29/07/2022	Irrigated for 30 mins

05/08/2022	Irrigated for 30 mins
08/08/2022	Irrigated for 30 mins
10/08/2022	Irrigated for 30 mins
12.08/2022	Irrigated for 30 mins
15/08/2022	Irrigated for 30 mins
25/08/2022	Hand weeded
7/11/2022	Samples taken from treatments 1, 2 and 3 for residue analysis

## Trial 2 – Milcote

Date	Notes
10/05/2022	Bed-formed
18/05/2022	Applied granular treatments in-furrow at drilling
18/05/2022	Drilled salad onions - . 6 rows per bed @ 25 cm with 60 seeds/m in the row
18/05/2022	Spray treatments applied along rows
18/05/2022	Irrigated for 30 mins
24/05/2022	Second Hallmark spray applied

b. Trial Photographs

c. Raw data

## Trial 1 – Leek Warwick Crop Centre

Emergence 23/5/22

Plot	Row				Total
	1	2	3	4	
1	6	3	6	6	21
2	9	3	3	1	16
3	3	2	0	0	5
4	4	1	0	0	5
5	0	3	2	2	7
6	3	2	1	1	7
7	5	1	5	0	11
8	4	5	1	0	10
9	2	5	1	3	11
10	12	4	2	1	19
11	1	0	2	2	5
12	3	1	1	0	5
13	6	3	0	1	10
14	2	3	0	0	5

15	5	5	2	1	13
16	5	0	2	4	11
17	5	2	9	3	19
18	7	4	2	2	15
19	4	3	7	1	15
20	6	0	2	0	8
21	9	5	2	5	21
22	3	1	2	2	8
23	1	0	2	1	4
24	5	0	2	1	8
25	11	5	17	9	42
26	10	8	10	1	29
27	6	3	1	8	18
28	17	9	10	6	42
29	10	4	6	10	30
30	10	2	3	0	15
31	5	0	2	0	7
32	9	0	10	5	24

Emergence 31/5/22

Plot	Row				Total
	1	2	3	4	
1	5	1	8	3	17
2	5	1	3	1	10
3	1	0	0	0	1
4	1	0	0	0	1
5	2	3	1	2	8
6	2	1	1	0	4
7	8	0	4	1	13
8	3	6	1	1	11
9	4	3	2	4	13
10	12	12	2	2	28
11	2	0	3	3	8
12	4	2	1	0	7
13	6	3	0	0	9
14	2	0	0	1	3
15	5	3	3	1	12
16	5	2	2	3	12
17	3	2	10	4	19
18	3	4	5	5	17
19	3	3	5	1	12
20	6	0	2	0	8
21	7	5	2	6	20
22	2	2	2	4	10
23	2	0	2	1	5

24	2	0	1	0	3
25	17	5	9	9	40
26	11	6	6	0	23
27	7	3	1	3	14
28	12	8	9	4	33
29	10	4	8	6	28
30	12	2	4	0	18
31	3	0	2	2	7
32	8	0	5	3	16

## Trial 2 – Salad onion Milcote

Emergence - 15/6/22

Plot	Row			Total	
	3	3	4		
1	81	71	83	79	314
2	52	62	70	76	260
3	77	72	96	80	325
4	90	95	81	86	352
5	74	80	62	58	274
6	90	82	74	82	328
7	82	78	86	87	333
8	51	44	46	52	193
9	61	59	55	64	239
10	71	86	75	86	318
11	64	65	66	72	267
12	80	74	71	100	325
13	77	81	72	73	303
14	73	78	55	73	279
15	81	88	80	75	324
16	67	73	79	74	293
17	49	39	65	51	204
18	69	61	48	60	238
19	75	80	94	91	340
20	72	74	73	77	296
21	75	83	76	78	312
22	71	79	60	84	294
23	87	73	56	70	286
24	62	89	58	71	280
25	75	69	79	92	315
26	48	51	49	74	222
27	58	59	54	62	233
28	95	80	88	88	351

29	67	75	85	84	311
30	68	78	82	91	319
31	88	81	68	80	317
32	73	79	57	69	278
33	75	81	66	80	302
34	55	45	79	77	256
35	46	53	59	64	222
36	58	57	61	57	233

									total (12m)	total (6m)
Force ST	78	86	70	84	86	83	86	87	660	330
	60	59	42	47	66	54	76	64	468	234
	65	80	67	68	62	64	68	75	549	274.5
	80	79	64	59	54	65	69	47	517	258.5

#### Emergence – 13/7/22

Plot	Row				Total
	3	3	4	4	
1	74	71	72	76	293
2	59	53	70	54	236
3	77	65	83	65	290
4	76	82	77	81	316
5	80	78	60	79	297
6	70	74	71	85	300
7	70	69	81	75	295
8	54	41	55	50	200
9	55	51	49	49	204
10	67	72	66	87	292
11	71	62	68	80	281
12	59	68	65	78	270
13	67	85	75	83	310
14	69	57	47	66	239
15	61	73	64	61	259
16	55	61	66	72	254
17	45	38	51	50	184
18	59	56	55	65	235
19	67	72	78	68	285
20	69	62	73	71	275
21	69	67	74	74	284

22	65	80	74	74	293
23	80	70	54	68	272
24	85	70	72	72	299
25	62	67	74	68	271
26	36	46	50	70	202
27	57	54	56	51	218
28	68	92	81	75	316
29	72	69	81	86	308
30	74	76	82	76	308
31	73	78	76	67	294
32	86	68	54	69	277
33	75	71	59	66	271
34	57	63	85	80	285
35	53	42	50	55	200
36	44	54	60	57	215

					total
Force ST	59	56	61	68	244
	60	62	68	51	241
	53	32	30	47	162
	59	57	56	62	234

**Weather data (recorded at Warwick Crop Centre)**

DATE	Temperature (°C)		09-09 Rainfall
	09-09 MAX	09-09 MIN	
01/04/2022	8.3	0.1	0
02/04/2022	9	-3.6	0
03/04/2022	10.7	-4.6	1.6
04/04/2022	13.8	3.7	0
05/04/2022	14.2	9.1	0.4
06/04/2022	13.8	9	0.2
07/04/2022	12.2	7.5	0
08/04/2022	11.6	-1.6	0
09/04/2022	11.3	-1	0
10/04/2022	12.9	-2.6	0
11/04/2022	17.5	3.1	0.8
12/04/2022	15.8	7.7	0.2
13/04/2022	18.3	10.4	0.4
14/04/2022	16.2	3.5	0
15/04/2022	22	4.3	0
16/04/2022	21.2	8.6	0
17/04/2022	19.6	4.3	0
18/04/2022	16.2	6.7	0
19/04/2022	15.6	5.7	0

20/04/2022	17.7	6.6	0
21/04/2022	18.2	5.2	0
22/04/2022	16.1	6.5	0
23/04/2022	15.9	7.3	0
24/04/2022	16.5	7.1	0
25/04/2022	14.1	3.7	0
26/04/2022	14.9	4.4	0
27/04/2022	10.9	0.1	0
28/04/2022	11.2	6.4	0
29/04/2022	12.7	7.3	0
30/04/2022	17.5	-1	0.2
01/05/2022	11.9	8.1	0.2
02/05/2022	15.7	8.8	0
03/05/2022	15.9	9.5	0.6
04/05/2022	16.4	8.3	1.4
05/05/2022	20.5	4.7	0
06/05/2022	18.7	8.1	1.4
07/05/2022	19.9	10.6	0
08/05/2022	18.8	9.5	0
09/05/2022	21.7	5.8	0
10/05/2022	20.4	13.6	4.8
11/05/2022	16.8	11.1	6.2
12/05/2022	15.9	6.6	0
13/05/2022	19.7	9.2	0
14/05/2022	21.6	4.9	0.8
15/05/2022	19	12	8.4
16/05/2022	20.7	13.1	1.8
17/05/2022	23.8	10.6	2.2
18/05/2022	20.7	8.9	5.6
19/05/2022	19.5	9.2	1
20/05/2022	18.5	10.9	0
21/05/2022	18.8	8.3	0
22/05/2022	20.9	6.5	0
23/05/2022	17.1	13	7.6
24/05/2022	17.2	9.4	2.4
25/05/2022	18.6	7.3	0.4
26/05/2022	18.8	8.9	0.2
27/05/2022	18.7	8.6	0
28/05/2022	18.6	6.6	0
29/05/2022	15.4	8.1	0
30/05/2022	16.1	7.5	1.6
31/05/2022	16	6.7	2.8
01/06/2022	18.2	5.5	0
02/06/2022	20.5	4.5	0
03/06/2022	20.7	8.3	0
04/06/2022	16.3	11	20.2

05/06/2022	12.6	9.7	1.4
06/06/2022	16.3	10.2	0
07/06/2022	21.4	9.1	2
08/06/2022	19.4	13.9	2.2
09/06/2022	18.3	9	0.2
10/06/2022	22.2	12.2	0
11/06/2022	20.8	10.4	0
12/06/2022	20	9.2	0
13/06/2022	18.8	8	0
14/06/2022	23.1	6.1	0
15/06/2022	25.2	7	0
16/06/2022	27.1	8.9	0
17/06/2022	30.5	12.9	0.4
18/06/2022	15.1	14.2	14.2
19/06/2022	17.5	7.8	0
20/06/2022	21.2	6.9	0
21/06/2022	24.7	6.8	0
22/06/2022	26.4	9.3	0
23/06/2022	22.3	12.1	0
24/06/2022	21.6	15	0
25/06/2022	20.2	10.8	0
26/06/2022	21.5	10.3	1.6
27/06/2022	19.6	10.6	1.8
28/06/2022	20.5	8.7	0.8
29/06/2022	21	13.2	0.2
30/06/2022	20.6	12.3	2.4
01/07/2022	21.9	10	0.6
02/07/2022	18.7	11	9.2
03/07/2022	20.7	7.5	0.2
04/07/2022	20.5	8.5	0
05/07/2022	22.5	6.7	0
06/07/2022	23.5	10.8	0
07/07/2022	23.6	13.9	0
08/07/2022	27	10.2	0
09/07/2022	25.6	11.2	0
10/07/2022	28.5	9.2	0
11/07/2022	31	11.2	0
12/07/2022	27.4	17.5	0
13/07/2022	25.5	13	0
14/07/2022	22.9	8.7	0
15/07/2022	25.2	8.1	0
16/07/2022	27.2	7.7	0
17/07/2022	31.6	14.5	0
18/07/2022	37.2	12.8	0.2
19/07/2022	39	16.7	0
20/07/2022	22.8	18.5	0



21/07/2022	21.8	12.5	0
22/07/2022	23.8	15.4	1.2
23/07/2022	23.6	13.9	0
24/07/2022	26.4	17.8	0.2
25/07/2022	23.2	15.9	0.2
26/07/2022	21.4	13.2	0
27/07/2022	22.8	7	0
28/07/2022	22.5	14.5	0
29/07/2022	25.8	14.6	0
30/07/2022	23.4	15.3	1.8
31/07/2022	25.2	17.4	0.8

d. Trial design

Trial 1 – Leek at Warwick Crop Centre

3	5	4	6	1	7	8	2
1	2	3	4	5	6	7	8
2	6	1	5	8	4	7	3
9	10	11	12	13	14	15	16
8	1	2	7	6	3	5	4
17	18	19	20	21	22	23	24
7	4	8	3	2	5	1	6
25	26	27	28	29	30	31	32

Trial 2 – Salad onion at Milcote

2	3	8	4	5	1	6	1	7
28	29	30	31	32	33	34	35	36
7	1	6	8	3	2	1	5	4
19	20	21	22	23	24	25	26	27
4	5	1	6	1	7	2	3	8
10	11	12	13	14	15	16	17	18
2	3	8	1	5	4	7	1	6
1	2	3	4	5	6	7	8	9