

# CP 205 AHDB Horticulture Efficacy Trials 2022

## Final Trial Report

<b>Work package:</b>	WP 2
<b>Title:</b>	Bean seed fly ( <i>Delia</i> spp.) control in legumes
<b>Crop</b>	Dwarf French beans
<b>Target</b>	Bean seed fly ( <i>Delia platura</i> and <i>Delia florilega</i> )
<b>Lead researcher:</b>	Becky Howard
<b>Organisation:</b>	PGRO
<b>Period:</b>	15 <sup>th</sup> March to 31 <sup>st</sup> December 2022
<b>Report date:</b>	December 2022
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<b>ORETO Number: (certificate should be attached)</b>	384 (PGRO) 381 (University of Warwick)

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  
08/03/23

Author's signature



# Trial Summary

## Introduction

The bean seed fly (*Delia platura* & *Delia florilega*) is a pest of over 40 crop species, causing the greatest problems in legumes and alliums. In recent years the most effective insecticide treatments have been seed treatments and when these treatments are lost, growers are left in a vulnerable position. The aim of these trials is to assess alternative treatments for management of bean seed fly on French beans.

## Methods

Several experimental active substances were evaluated for control of bean seed fly in French beans in 2022. Trials were established at Stubton, Lincolnshire and University of Warwick Crop Centre using a randomised complete block design with four replicates per treatment. Products were applied using three techniques and depending on the product: Pepper pot treatment across the plot prior to drilling (Stubton), granular in-furrow applied using the drill (Warwick), spray applications following drilling (both sites). The following treatments were included in French bean trials at Stubton in Lincolnshire and Warwick Crop Centre. Organic matter was incorporated at both sites to attract bean seed flies. The trials were drilled on 17<sup>th</sup> June (Stubton) and 27 April (Warwick Crop Centre).

**Table 1:** Treatments included in trials to control bean seed fly at Stubton, Lincolnshire and Warwick Crop Centre in 2022.

Product	A.I.	Conc.	Application rate	Application time
Untreated	–	–	–	–
AHDB 9727	N/D	N/D	16 kg/ha	At drilling as a granule
AHDB 9833	N/D	N/D	15 kg/ha	At drilling as a granule
AHDB 9834	N/D	N/D	0.175 l/ha	Pre-emergence ground spray
AHDB 9705	N/D	N/D	3 billion/ha	Pre-emergence ground spray
AHDB 9896	N/D	N/D	20 kg/ha	At drilling as a granule
Tracer	Spinosad	48% w/v	0.2 l/ha	Pre-emergence ground spray
Hallmark Zeon	Lambda-cyhalothrin	10% w/v	0.075 l/ha	Pre-emergence and early emergence ground spray

## Results

None of the treatments tested in these trials gave significant control of bean seed fly in French beans at either site. There were no significant differences in control of bean seed fly between treatments, and therefore no recommendations can be made from the results of these trials. However, establishment was better in the plots treated with AHDB 9727 at Warwick, and the lowest levels of damage were recorded in the plots treated with Hallmark Zeon and AHDB 9833 at Stubton.

The two French bean trials appear to confirm that recent incorporation of organic matter and cultivation are likely to increase the incidence of bean seed fly larvae. It also appears that treatments can be overwhelmed if fly pressure is too high.

**Take home message:**

No financial benefits can be extrapolated from these trials due to the lack of efficacy of the treatments tested here.

# SCIENCE SECTION

## Objectives

1. Agree treatments with AHDB, companies and industry contact.
2. Establish trial/s at a time and in locations that are likely to attract egg-laying by female bean seed flies.
3. Assess a range of insecticide treatments for efficacy against bean seed fly larvae.
4. Report on the trial and disseminate information to the industry.

## Trial 1

### Methods

A trial at Stubton, Lincolnshire was drilled on 5th May 2022. Prior to drilling, the trial area was cultivated using a power harrow, and layers mash was applied to all plots at 50g/m<sup>2</sup> to increase the level of organic material in the soil. Fertiliser and granular treatments (Table 1) were applied using a 'pepper pot' method. French beans (variety Jameson) were drilled. The trial failed to establish due to overwhelming damage from bean seed fly larvae that killed most plants.

The trial was re-drilled at Stubton on 17th June 2022. Prior to drilling, the trial area was cultivated, fertiliser (N:P:K 12:11:18) applied at 1,250 kg/ha, and granular treatments (Table 1) were applied using a 'pepper pot' method. No additional organic material was added. French beans (variety Faraday) were drilled at a seed rate of 93 kg/ha to give a plant density of 45 plants per square metre. After drilling, the remaining treatments were applied as ground sprays using a hand operated compressed air boom sprayer with a width of two meters.

Assessments of bean seed fly impact were carried out on 30th June and 1st July by recording the number of plants per two-metre length along two rows per plot. All plants were removed by digging them from each row, and the stem base and cotyledon leaves were evaluated for tunnelling damage. The number of seedlings that had not emerged, and plants showing symptoms of 'baldhead' were recorded. Baldhead is a physiological disorder caused by mechanical damage to the seed, producing damage at the growing point, stunting and malformation, leading to incomplete development of true leaves and other plant parts (Appendix b). Results were reported as percentages and analysis of variance carried out using STAR statistical software to determine statistically significant differences between treatments.

When mature, samples were taken from treatments 1, 2, 3 and 4 and sent for residue analysis. One pod from ten plants/plot was taken for each treatment (40 pods/treatment), trimmed and frozen before transport to SGS, an accredited residue testing laboratory.

### 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 1/34 (2)	Efficacy evaluation of insecticides for control of <i>Delia platura</i> and <i>Delia florilegia</i>	
PP 1/135	Phytotoxicity assessment	

## Test site

Item	Details
Location address	Dyson Farming, Moor Farm, Brandon Road, Stubton, Lincolnshire, NG32 2AY. OS Grid Reference SK 9018 4968.
Crop	Dwarf French beans
Cultivar	Faraday
Soil or substrate type	Sandy clay loam; P: K: Mg 1:1:2. pH 7.9; Organic Matter without added organic material (LOI) 4.7-5.4% w/w.
Agronomic practice	Standard
Prior history of site	<b>Arable rotation</b>

## Trial design

Item	Details
Trial design:	Randomised complete block
Number of replicates:	4
Row spacing:	22.5 cm
Plot size: (w x l)	1.83 m x 5 m
Plot size: (m <sup>2</sup> )	9.15
Number of plants per plot:	N/A
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
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
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
Tracer	Spinosad	Tracer	D074276100	48% w/v	SC	None
Hallmark Zeon	Lambda-cyhalothrin	Hallmark Zeon	BSW00F0670	10% w/v	CS	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
1	–	–	–	–
2	AHDB 9727	N/D	16 kg/ha	A
3	AHDB 9833	N/D	15 kg/ha	A
4	AHDB 9834	N/D	0.175 l/ha	B
5	AHDB 9705	N/D	n/a	B
6	AHDB 9896	N/D	20 kg/ha	A

7	Spinosad	96 g/ha	0.2 l/ha	C
8	Lambda-cyhalothrin	7.5 g/ha	0.075 l/ha	B

### Application details

	Application A	Application B	Application C	Application D
Application date	17/06/22	17/06/22	17/06/22	
Time of day	10.45 am	10.45 am	10.45 am	
Crop growth stage (Max, min average BBCH)	00	00	00	
Crop height (cm)	0	0	0	
Crop coverage (%)	0	0	0	
Application Method	Granule pepper pot before drilling	Handheld sprayer	Handheld sprayer	
Application Placement	By hand			
Application equipment	NA	Compressed air boom sprayer	Compressed air boom sprayer	
Nozzle pressure	NA	2 bar	2 bar	
Nozzle type	NA	Lurmark	Lurmark	
Nozzle size	NA	02F110	02F110	
Application water volume/ha	NA	200 l	600 l	
Temperature of air - shade (°C)	25	25	25	
Relative humidity (%)	45	45	45	
Wind speed range (m/s)	10	10	10	
Dew presence (Y/N)	N	N	N	
Temperature of soil - 2-5 cm (°C)				
Wetness of soil - 2-5 cm	Dry	Dry	Dry	
Cloud cover (%)	2	2	2	

### 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 at SITE 1	<i>Delia platura/florilega</i>	HYLEPL/HYLEFG	NA	72.95%	72.95%

## Assessment details

Evaluation date	Evaluation Timing (DA)*		Crop Growth Stage (BBCH)	Evaluation type (efficacy, phytotoxicity)	Assessment
	After first conventional insecticides	After first bio-pesticides			
30/06/22	13	13	12	Efficacy and phytotoxicity	Bean seed fly Phytotoxicity
29/08/22	73	73	79	Residue analysis	Residue analysis

\* DA – days after application

## Statistical analysis

Results were reported as percentages and analysis of variance carried out using STAR statistical software to determine statistically significant differences between treatments.

## Trial 2

### Methods

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 27 April, the trial area was cultivated with a bed-former. On the day of cultivation, French beans (variety Jameson) were drilled using an Oyjard drill at a rate of 10 seeds/m with 4 rows per bed. Granular treatments were applied with the seed through the seed drill.

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 70 g/m<sup>2</sup>. The Hallmark Zeon treatment was re-applied on 5 May (one week after drilling).

Emergence counts were carried out on 17 May by recording the number of plants in a 4 m length in all four rows per plot. The trial was harvested on 19 May, removing all plants by digging from 3 m of all 4 rows per plot. The stem base and leaves were evaluated for tunnelling damage and placed in one of four categories: 0 - no damage, 1 - light damage to stem or leaf, 2 - heavy damage with aerial growth and 3 - heavy damage with no aerial growth. Category 3 included plants showing symptoms of 'baldhead'.

### 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	Dwarf French beans
Cultivar	Jameson
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	Standard
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:	200
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	16 kg/ha	A
3	AHDB 9833	N/D	15 kg/ha	B
4	AHDB 9834	N/D	0.175 ml/ha	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/a	B
8	AHDB 9896	N/D	20 kg/ha	A



## Application details

	Application A	Application B	Application C
Application date	27/4/22	27/4/22	5/5/22
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	Oyjard seed drill	Berthoud Vermorel 2000HP	
Nozzle pressure	n/a	2 bar	
Nozzle type	n/a	Lurmark	
Nozzle size	n/a	05F110	
Application water volume/ha		1000	
Temperature of air - shade (°C)	10	10	18
Relative humidity (%)	62	62	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		

## Statistical analysis

All analyses were carried out using Analysis of Variance (ANOVA) using the data analysis package in Excel. The analyses were interpreted using treatment means together with standard errors for the differences (SED) between means and associated 5% least significant differences (LSD).

## Supplementary pot trial

To assess the efficacy of the granular treatments under controlled conditions using laboratory-reared bean seed fly eggs a small pot trial was devised.

Peas were germinated in wet sand at 20°C and then placed in Petri dishes containing dampened sand (egg laying sites). The egg laying sites were placed into a cage containing adult bean seed flies from the culture maintained at Warwick Crop Centre and left overnight to allow the flies to lay eggs. The eggs were washed out of the sand onto a muslin filter and counted onto moistened black filter paper squares (20 eggs/square).

FP7 pots (10 per treatment) were filled up to 3 cm from the top of the pot with M2 compost and one French bean seed (cv Jameson) was sown in each pot. Pre-weighed granule samples (Table 2) were added to the pots in a band across the seed and the pot was topped up with a further 2 cm of M2 compost.

The eggs from one filter paper square were washed into a small indentation made in the compost surface in each pot and the pots were randomized, caged, watered and maintained at 20°C (16:8 hours, light: dark) in a controlled environment room for 2 weeks.

The pots were removed, and the seedlings were scored for damage (0 = no damage, 1 = damage to leaves only, 2 = Bald head, 3 = no leaves and 4 = dead). The seedlings were dissected to find larvae and the larvae were counted. The compost was mixed with cold water to allow pupae to float to the surface and the numbers of pupae were counted.

The trial was repeated with a further 10 replicates of each treatment and the same methodology.

**Table 2:** Granule treatments for pot trials conducted at Warwick Crop Centre in 2022.

Product	Rate (kg product/ha)	g product/pot
AHDB 9727	16	0.066
AHDB 9896	20	0.080
AHDB 9833	15	0.060

## Statistical analysis

All analyses were carried out using Analysis of Variance (ANOVA) using the data analysis package in Excel. The analyses were interpreted using treatment means together with standard errors for the differences (SED) between means and associated 5% least significant differences (LSD).

## Results

### Trial 1

The trial drilled at Stubton on 5th May 2022 failed due to very high levels of damage from bean seed fly larvae. None of the treatments successfully controlled damage and very few plants established in plots (Appendix b).

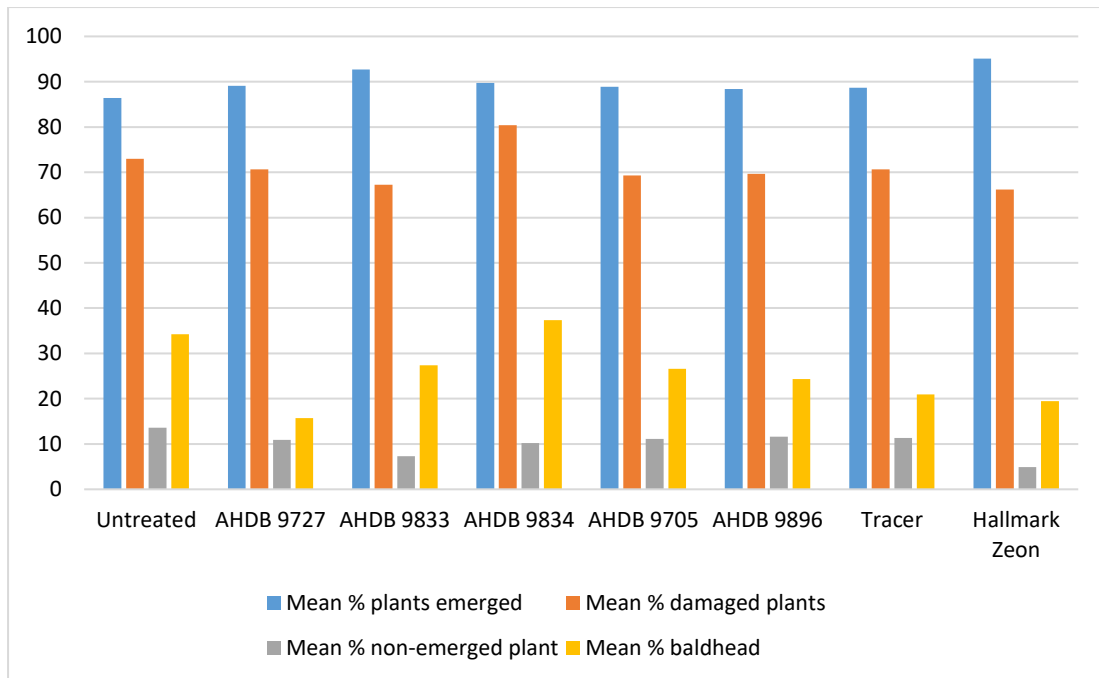
In discard plots and pathways, establishment was slightly better, although plant density was still poor (Appendix b). These areas did not have additional organic material applied at drilling.

The trial drilled at Stubton on 17th June established better and results are below.

**Table 3:** Mean percentage plants emerged, damaged plants, non-emerged plants, plants showing baldhead symptoms and phytotoxicity at Stubton, Lincolnshire, recorded on 30<sup>th</sup> June and 1<sup>st</sup> July 2022. Phytotoxicity was scored on a 0-10 scale, where 0 = dead plants and 10 = no damage. Two 2 metre rows were evaluated per plot.

TRT#	Treatments	Mean % plants emerged	Mean % damaged plants	Mean % non-emerged plant	Mean % baldhead	Mean phytotoxicity score
1	Untreated	86.43	72.95	13.57	34.25	10
2	AHDB 9727	89.11	70.66	10.89	15.72	10
3	AHDB 9833	92.70	67.25	7.30	27.41	10
4	AHDB 9834	89.76	80.40	10.24	37.33	10
5	AHDB 9705	88.88	69.28	11.12	26.57	10
6	AHDB 9896	88.39	69.68	11.61	24.31	10
7	Tracer	88.66	70.64	11.34	20.98	10
8	Hallmark Zeon	95.07	66.19	4.93	19.48	10
F-value		1.54	0.54	1.54	1.99	
P-value		0.1732 (ns)	0.7998 (ns)	0.1732 (ns)	0.0744 (ns)	
CV%		6.91	23.76	61.36	56.80	

There were no statistically significant differences in the percentage of plants emerged, damaged plants, non-emerged plants or baldhead symptoms between treatments, and no phytotoxicity was observed in any of the plots (Table 3, Figure 1). The lowest level of larval damage was recorded in treatment 8 (Hallmark Zeon applied as a foliar application) and treatment 3 (AHDB 9833). The highest level of larval damage was observed in treatment 4 (AHDB 9834), which also had the highest level of plants with baldhead symptoms.



**Figure 1:** Mean percentage plants emerged, non-emerged plants, plants showing baldhead symptoms and damage to plants at Stubton, Lincolnshire, recorded on 30<sup>th</sup> June and 1<sup>st</sup> July 2022. Two 2 metre rows were evaluated in each plot.

### Residues

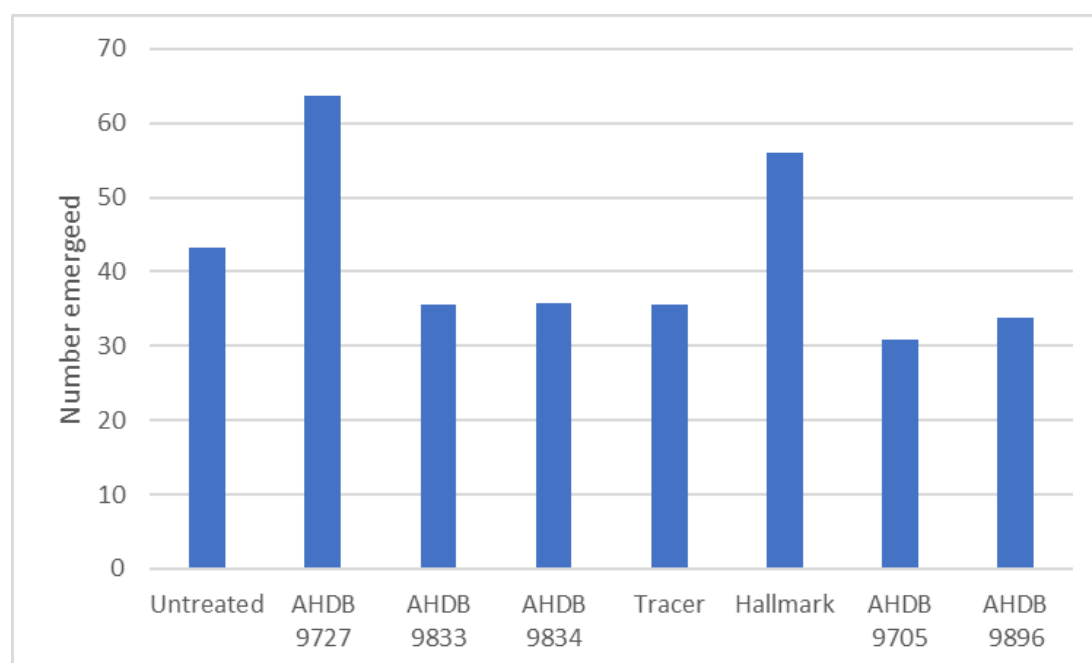
No residues were detected above the limit of detection in any of the treatments tested in this study (Treatments 1, 2, 3 and 4, Appendix).

### Trial 2

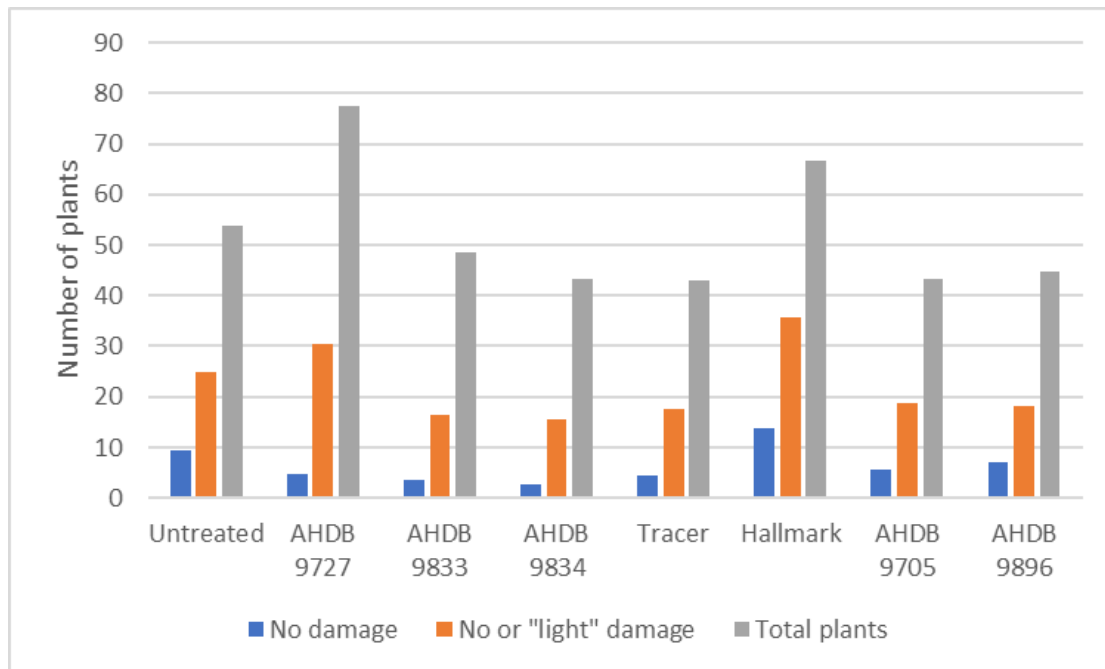
There was no evidence of phytotoxicity with any treatment. There were very high levels of damage from bean seed fly larvae in the French bean trial drilled at Warwick Crop Centre. The mean number of plants emerged in control plots was 43 which represented 25.6% of the total number drilled (160 seeds). None of the treatments successfully controlled damage and there were no significant differences between treatments (Table 4, Figures 2 and 3) when considering either emergence or plant damage. There was some evidence ( $p = 0.071$ ) that one treatment (AHDB 9727 granules) had increased the total number of plants at harvest compared with the untreated control but there was no evidence of an increase in the numbers of healthy, viable plants.

**Table 4:** Mean number of French beans emerged on 17 May, numbers of plants in damage categories and total plants assessed per treatment on 19 May at Warwick Crop Centre in 2022.

TRT	17 May	Numbers at harvest – 19 May				
	Number emerged	No damage	No or "light" damage	Heavy damage – with aerial growth	Heavy damage – no aerial growth	Total number of plants
Untreated	43	10	25	16	14	54
AHDB 9727	64	5	31	21	26	78
AHDB 9833	36	4	17	15	17	49
AHDB 9834	36	3	16	15	13	43
Tracer	36	5	18	14	12	43
Hallmark	56	14	36	15	16	67
AHDB 9705	31	6	19	9	16	43
AHDB 9896	34	7	18	15	12	45
F-value	1.749	1.103	1.394			2.201
P-value	0.145	0.393	0.253			0.071
SED	12.71	4.90	8.89			12.27
5% LSD	26.23	10.12	18.36			25.32
df	24	24	24			24



**Figure 2:** Mean number of French beans emerged per treatment (4m x 4 rows) at Warwick Crop Centre in 2022.



**Figure 3:** Mean number of French bean plants with no damage, no or light damage and total plants assessed at Warwick Crop Centre in May 2022.

## Supplementary pot trial

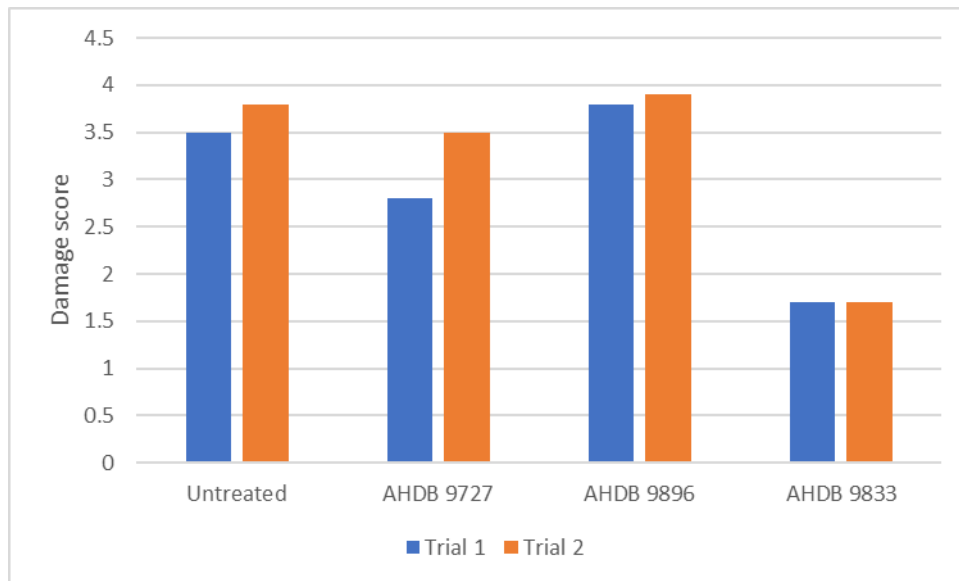
### Results

There was no evidence of phytotoxicity with any treatment. There were very high levels of damage from bean seed fly larvae. Bean seed fly larvae and pupae were found in all treatments and more were recovered in trial 2 compared with trial 1. AHDB 9833 significantly reduced damage and number of pupae plus larvae recovered ( $p < 0.05$ ) compared with the untreated control. The other two treatments were largely ineffective. Results are presented in Table 5 and Figures 4 and 5.

**Table 5:** Mean bean seed fly damage score and number of larvae plus pupae in French bean pot trials at Warwick Crop Centre.

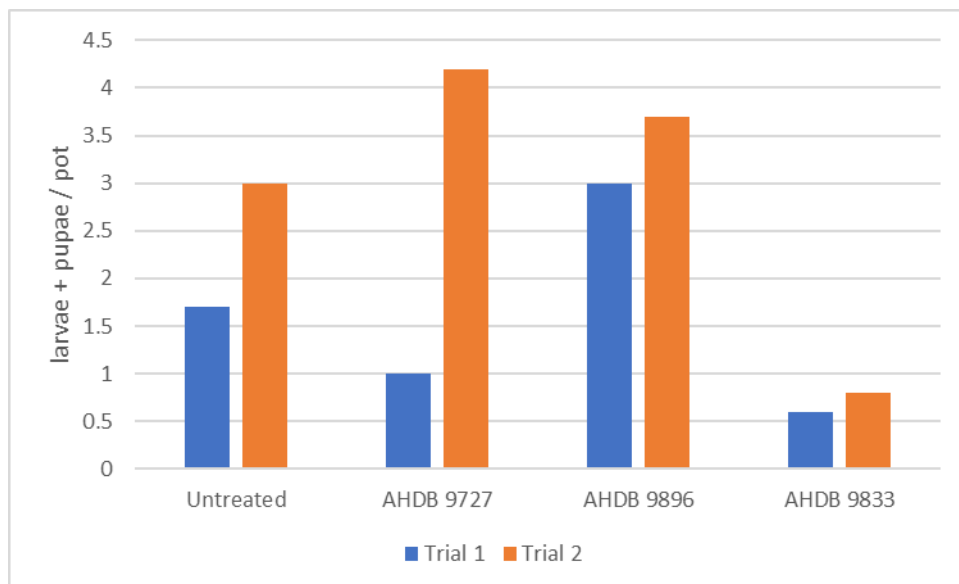
Treatment	Damage score		Number of larvae + pupae	
	Trial 1	Trial 2	Trial 1	Trial 2
Untreated	3.5	3.8	1.7	3
AHDB 9727	2.8	3.5	1	4.2
AHDB 9896	3.8	3.9	3	3.7
AHDB 9833	1.7	1.7	0.6	0.8
F-value	13.160	10.897	5.360	4.567
P-value	<0.001	<0.001	0.004	0.008
SED	0.364	0.442	0.643	0.992
5% LSD	0.737	0.896	1.305	2.013
df	36	36	36	36

(0 = no damage, 1 = damage to leaves only, 2 = Bald head, 3 = no leaves and 4 = dead)



**Figure 4:** Mean bean seed fly damage score for French bean plants in pot trials at Warwick Crop Centre.

(0 = no damage, 1 = damage to leaves only, 2 = Bald head, 3 = no leaves and 4 = dead)



**Figure 5:** Mean number of larvae plus pupae per pot found in French bean pot trials at Warwick Crop Centre.

## Discussion

The trial drilled at Stubton on 5th May 2022 failed due to high levels of bean seed fly damage in all plots. The discard areas and pathways did not have additional organic material added at drilling, and established better than all the trial plots, in which layers mash had been applied. When the trial was re-drilled on 17th June, no additional organic material was added, and the trial established well.

There were no significant differences in control of bean seed fly between treatments, and therefore no recommendations can be made from the results of these trials. However, establishment was better in the plots treated with AHDB 9727 at Warwick, and the lowest levels of damage were recorded in the plots treated with Hallmark Zeon and AHDB 9833 at Stubton.

Although ineffective in either field trial, AHDB 9833 worked well in pot trials at Warwick Crop Centre despite the high insect pressure applied (20 eggs per pot/seed). This could in part be due to the careful and precise positioning of the granules around the seed at sowing but there may be other factors to consider such as temperature and the relative response of the growing seed versus the growing and feeding larvae. It is interesting to note the difference in the numbers of insects recovered between the two pot trials which were done in the same controlled environment room, two weeks apart. This may suggest that small differences in conditions could lead to large differences in insect survival, with or without chemical treatment.

## **Conclusions**

Due to the lack of efficacy of treatments tested in these trials, no conclusions may be drawn. Bean seed fly levels were very high at Stubton and Warwick Centre, which led to all products being overwhelmed.

## **Acknowledgements**

We would like to acknowledge Phil Langley at G's Fresh for his support, Dyson Farming for site provision at Stubton, Lincolnshire, Syngenta Seeds for provision of Jameson French bean seed and Cobrey Farms for provision of Faraday French bean seed.

## **References**



## Appendix

### a. Trial diary

#### Site 1 - Stubton

Date	Notes
05/05/22	Cultivated and drilled variety Jameson at Stubton, Lincolnshire
05/05/22	Application of layers mash
05/05/22	Application of fertiliser and granular insecticide treatments
05/05/22	Application of ground spray treatments
17/06/22	Cultivated and drilled variety Faraday at Stubton, Lincolnshire
17/06/22	Application of fertiliser and granular insecticide treatments
17/06/22	Application of ground spray treatments
30/06/22 – 01/07/22	Bean seed fly damage assessment
29/08/22	Bean pod samples collected for residue analysis

#### Site 2 – 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
27/04/2022	Applied Nitrogen @ 100 kg/ha
27/04/2022	Bed-formed
27/04/2022	Applied granular treatments in-furrow with beans at drilling
27/04/2022	Drilled beans - 4 rows per bed @ 35 cm with 10 seeds/m in the row
27/04/2022	Set fencing and irrigation
27/04/2022	Spray treatments applied along rows
27/04/2022	Irrigated for 30 mins
29/04/2022	Applied Blood, Fish and Bone @ 3.125 kg/bed
29/04/2022	Irrigated for 1 hour
05/05/2022	Second Hallmark spray applied
06/05/2022	Irrigated for 30 mins
09/05/2022	Irrigated for 30 mins
20/05/2022	Harvested beans

b. Trial Photographs

**Trial 1**



French beans showing symptoms of baldhead and tunnelling caused by damage to seed and stems from bean seed fly larvae at Stubton, Lincolnshire.

			
TRT1 D1 20 May	TRT2 D1 20 May	TRT3 D1 20 May	TRT4 D1 20 May
			
TRT5 D1 20 May	TRT6 D1 20 May	TRT7 D1 20 May	TRT8 D1 20 May

Images taken of all treatments in the first drilling at Stubton, Lincolnshire on 20th May 2022.



Discard area (left) next to trial plots (right) at the first failed drilling at Stubton, Lincolnshire.

## **Trial 2**



Bald headed French bean observed in the field





Typical damage to French beans observed in the field



Severely damaged French beans dug from the field



Severely damaged French bean dug from the field with bean seed fly larvae

c. Raw data

Trial 1 – French Beans PGRO, Stubton, Lincolnshire

Plot	Trt	Row	Emerged	Damaged	Non-emerged	Baldhead	Total Plants
101	1	1	27	23	4	8	31
101	1	2	7	9	4	3	11
102	5	1	12	9	4	9	16
102	5	2	19	17	3	4	22
103	7	1	17	21	4	6	21
103	7	2	13	14	4	4	17
104	2	1	16	14	2	3	18
104	2	2	16	16	3	3	19
105	8	1	20	22	2	7	22
105	8	2	31	18	1	4	32
106	4	1	21	20	2	16	23
106	4	2	28	32	7	3	35
107	6	1	12	15	4	7	16
107	6	2	23	18	3	7	26
108	3	1	26	27	1	11	27
108	3	2	25	20	1	14	26
201	6	1	27	21	3	3	30
201	6	2	29	25	2	0	31
202	8	1	19	4	0	2	19
202	8	2	17	16	2	1	19
203	2	1	22	15	2	0	24
203	2	2	23	20	3	6	26
204	3	1	19	10	2	8	21
204	3	2	23	20	5	4	28
205	7	1	21	23	2	2	23
205	7	2	21	15	2	3	23
206	5	1	24	22	1	5	25
206	5	2	30	25	2	2	32
207	1	1	23	19	3	5	26
207	1	2	23	17	0	7	23
208	4	1	15	15	1	9	16
208	4	2	25	22	2	5	27
301	5	1	17	16	1	6	18
301	5	2	11	9	1	6	12
302	4	1	26	15	2	9	28
302	4	2	20	18	2	5	22
303	3	1	21	18	1	1	22
303	3	2	33	21	1	11	34
304	1	1	16	13	2	9	18
304	1	2	15	14	4	7	19
305	6	1	16	15	1	1	17
305	6	2	26	14	1	17	27
306	8	1	24	14	1	8	25

306	8	2	17	16	1	3	18
307	7	1	21	12	2	3	23
307	7	2	18	12	1	6	19
308	2	1	26	23	4	8	30
308	2	2	14	15	3	3	17
401	8	1	26	21	2	8	28
401	8	2	27	13	0	5	27
402	5	1	18	5	4	1	22
402	5	2	23	17	2	6	25
403	1	1	18	13	0	9	18
403	1	2	27	20	5	11	32
404	4	1	36	27	4	23	40
404	4	2	13	13	2	5	15
405	3	1	27	18	2	5	29
405	3	2	20	8	2	4	22
406	6	1	20	8	3	4	23
406	6	2	24	20	5	8	29
407	2	1	29	21	3	5	32
407	2	2	18	6	0	2	18
408	7	1	23	17	3	6	26
408	7	2	18	7	1	5	19

## Trial 2 – French Beans Warwick Crop Centre

Emergence – 17/5/22

Plot	Row				Total
	1	2	3	4	
1	30	18	26	22	96
2	6	3	8	5	22
3	16	10	25	16	67
4	17	5	6	6	34
5	13	12	21	16	62
6	12	6	6	17	41
7	27	20	7	18	72
8	19	10	11	13	53
9	27	13	8	8	56
10	7	3	2	7	19
11	10	5	10	15	40
12	16	15	6	8	45
13	15	5	7	6	33
14	18	2	13	5	38
15	19	24	15	18	76
16	17	5	5	4	31
17	23	9	12	10	54
18	3	0	0	2	5
19	16	11	11	3	41

20	8	5	2	2	17
21	17	13	1	4	35
22	13	1	6	12	32
23	12	2	7	7	28
24	12	6	5	9	32
25	19	4	1	1	25
26	3	1	9	5	18
27	22	8	9	5	44
28	15	3	5	4	27
29	34	8	4	12	58
30	13	7	15	20	55
31	20	3	5	7	35
32	16	4	12	14	46

Damage – 19/5/22

Plot	No damage	Light damage on stem or leaf	Heavy damage with arial growth	Heavy damage with no arial growth	Total
1	37	32	14	7	90
2	1	11	13	18	43
3	2	21	39	17	79
4	5	10	9	14	38
5	16	14	24	17	71
6	15	10	12	13	50
7	10	33	25	22	90
8	1	10	31	13	55
9	8	19	20	9	56
10	2	10	2	9	23
11	2	26	11	5	44
12	11	21	12	16	60
13	9	8	7	12	36
14	5	9	17	9	40
15	8	39	12	31	90
16	10	14	9	5	38
17	4	19	8	39	70
18	0	3	6	7	16
19	2	12	16	13	43
20	2	5	11	16	34
21	10	13	10	12	45
22	5	10	11	14	40
23	1	11	18	28	58
24	11	12	16	11	50
25	0	12	14	10	36
26	3	5	7	19	34
27	4	20	14	21	59



28	3	7	7	9	26
29	5	24	26	16	71
30	6	24	16	12	58
31	5	20	13	29	67
32	2	21	25	24	72

### Supplementary pot trials - French Beans Warwick Crop Centre

#### Trial 1

Treatment	Rep	Score	Larvae	Pupae	Total
1	1	4	0	3	3
1	2	2	0	0	0
1	3	4	2	2	4
1	4	4	0	1	1
1	5	2	1	0	1
1	6	3	1	0	1
1	7	4	2	0	2
1	8	4	1	1	2
1	9	4	0	1	1
1	10	4	2	0	2
2	1	3	0	1	1
2	2	4	0	1	1
2	3	3	0	1	1
2	4	4	1	1	2
2	5	2	1	0	1
2	6	3	1	0	1
2	7	3	0	0	0
2	8	2	2	0	2
2	9	2	1	0	1
2	10	2	0	0	0
3	1	4	0	0	0
3	2	4	0	1	1
3	3	4	0	3	3
3	4	4	0	2	2
3	5	4	0	7	7
3	6	4	1	4	5
3	7	2	1	0	1
3	8	4	3	2	5
3	9	4	1	0	1
3	10	4	0	5	5
4	1	1	0	0	0
4	2	1	0	0	0
4	3	2	0	0	0
4	4	2	1	0	1
4	5	4	0	3	3

4	6	1	0	0	0
4	7	1	1	0	1
4	8	2	0	0	0
4	9	1	0	1	1
4	10	2	0	0	0

Trial 2

Treatment	Rep	Score	Larvae	Pupae	Total
1	1	4	4	1	5
1	2	4	0	5	5
1	3	4	0	6	6
1	4	2	2	1	3
1	5	4	2	0	2
1	6	4	0	1	1
1	7	4	0	3	3
1	8	4	0	2	2
1	9	4	1	1	2
1	10	4	0	1	1
2	1	4	6	5	11
2	2	4	0	3	3
2	3	4	1	6	7
2	4	4	0	1	1
2	5	4	0	6	6
2	6	2	3	0	3
2	7	2	3	0	3
2	8	3	0	5	5
2	9	4	0	3	3
2	10	4	0	0	0
3	1	4	0	5	5
3	2	4	0	1	1
3	3	4	3	3	6
3	4	4	0	0	0
3	5	3	0	1	1
3	6	4	0	5	5
3	7	4	3	1	4
3	8	4	0	6	6
3	9	4	0	3	3
3	10	4	0	6	6
4	1	1	0	0	0
4	2	1	0	1	1
4	3	0	0	0	0
4	4	1	3	0	3
4	5	1	1	0	1
4	6	4	0	1	1
4	7	1	0	0	0

4	8	4	0	0	0
4	9	4	0	2	2
4	10	0	0	0	0

d. Trial design

	<b>7</b>	<b>2</b>	<b>6</b>	<b>3</b>	
	408	407	406	405	
Rep 4	<b>8</b>	<b>5</b>	<b>1</b>	<b>4</b>	
	401	402	403	404	
	<b>2</b>	<b>7</b>	<b>8</b>	<b>6</b>	
	308	307	306	305	
Rep 3	<b>5</b>	<b>4</b>	<b>3</b>	<b>1</b>	
	301	302	303	304	
	<b>4</b>	<b>1</b>	<b>5</b>	<b>7</b>	
	208	207	206	205	
Rep 2	<b>6</b>	<b>8</b>	<b>2</b>	<b>3</b>	
	201	202	203	204	
	<b>3</b>	<b>6</b>	<b>4</b>	<b>8</b>	
	108	107	106	105	
Rep 1	<b>1</b>	<b>5</b>	<b>7</b>	<b>2</b>	
	101	102	103	104	

*Trial layout at Stubton, Lincolnshire in 2022.*

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

*Trial layout for French beans at Warwick Crop Centre 2022.*

e. ORETO certificates



# Certificate of

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

*This certifies that*

**PGRO Research 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  
Biologicals and Semiochemicals**

Date of issue: 9 January 2018  
Effective date: 1 January 2018  
Expiry date: 31 December 2022

Signature

  
*Authorised signatory*

Certification Number

ORETO 384



Chemicals Regulation Division



Department of  
Agriculture and  
Rural Development

f. Meteorological data at Stubton, Lincolnshire

Weather data Stubton 2022					
Date	Temperature		Humidity	Wind Speed	Precipitation Accum.
	High °C	Avg °C	Avg %	Avg km/h	Sum mm
01-May	14.06	11.52	99.87	0.6	0
02-May	16.72	12.41	93.68	0.7	0.4
03-May	13.62	10.57	99.85	0.8	2.6
04-May	17.44	11.77	99.82	1.1	3.6
05-May	20.85	13.17	85.32	0.5	0
06-May	19.16	13.41	93.24	1.1	3.2
07-May	17.74	12.99	99.66	1.5	1
08-May	17.89	11.96	86.21	1.2	0
09-May	20.42	14.58	78.16	2	0
10-May	20.7	16.26	74.25	2.2	0
11-May	16.25	12.31	96.35	1.7	8.6
12-May	17.08	11.89	82.03	1.5	0
13-May	20.17	14.49	80.05	2.1	0
14-May	22.9	15.66	76.83	0.8	0
15-May	21.44	14.96	95.82	2.2	0.6
16-May	23.22	16.23	95.11	1.7	4.6
17-May	24.12	17.79	84.64	1.7	0.6
18-May	21.25	15.86	85.05	1.4	9.8
19-May	20.53	14.91	87.24	0.6	0
20-May	18.11	13.81	94.81	1.2	0.4
21-May	19.19	13.7	88.91	1.1	0
22-May	22.02	15.61	87.39	1.2	0
23-May	18.69	14.49	91.24	0.6	4.6
24-May	18.29	12.78	87.42	1	2
25-May	19.39	13.44	91.9	1.8	0
26-May	19.89	13.92	99.28	1.7	2
27-May	17.99	13.09	74.85	1.6	0.2
28-May	17.65	11.22	83.58	1	0
29-May	16.39	10.19	89.68	1.3	0
30-May	15.8	9.84	98.41	0.9	3.2
31-May	16.14	10.51	99.78	0.6	8.2
01-Jun	18.8	11.3	96.95	0.5	2.4
02-Jun	19.84	13.08	81.5	0.7	0.2
03-Jun	19.78	13.82	93.09	2	0
04-Jun	15.25	12.19	99.88	2.8	0
05-Jun	11.34	10.43	99.73	1.6	19.8
06-Jun	14.35	11.6	99.77	0.6	3.4
07-Jun	21.68	14.23	90.08	0.7	0
08-Jun	21.4	16.18	94.46	1.2	3.4

Weather data Stubton 2022					
Date	Temperature		Humidity	Wind Speed	Precipitation Accum.
	High °C	Avg °C	Avg %	Avg km/h	Sum mm
09-Jun	19.89	14.81	91.62	1.5	0.2
10-Jun	22.35	17.02	80.46	1.9	0
11-Jun	21.92	15.99	82.81	2	0.6
12-Jun	21.2	14.98	75.84	1.3	0
13-Jun	18.66	14.36	85.74	0.7	0
14-Jun	23.94	16.34	80.27	0.5	0
15-Jun	27.51	17.45	80.3	0.3	0
16-Jun	26.98	19.11	74.95	0.4	0
17-Jun	31.03	23.18	69.44	1.4	0
18-Jun	16.93	13.86	99.78	0.4	7
19-Jun	19.91	13.19	90.82	0.7	0.2
20-Jun	21.73	14.76	81.55	0.7	0
21-Jun	25.51	17.98	69.48	0.5	0
22-Jun	27.96	19.67	75.51	0.3	0
23-Jun	24.98	19.08	76.24	0.6	0
24-Jun	23.17	17.26	90.87	1.3	0
25-Jun	22.45	16.86	71.49	2.4	0
26-Jun	22.74	16.36	69.55	2.6	0
27-Jun	21.45	14.68	81.93	1.5	0.6
28-Jun	22.6	15.8	73.84	2.1	0
29-Jun	23.8	17.42	80.39	1.6	1.4
30-Jun	21.15	15.73	85.73	0.7	0
01-Jul	22.03	15.25	85.93	1.1	0
02-Jul	19.8	14.61	99.06	1.8	2.8
03-Jul	22.21	14.96	88.95	0.8	0
04-Jul	21.95	14.89	79.25	1.1	0
05-Jul	22.47	15.61	78.28	0.9	0
06-Jul	23.06	17.26	93.19	1.3	0
07-Jul	26.42	19.05	79.04	0.9	0
08-Jul	28.64	19.87	74.75	0.8	0
09-Jul	26.93	19.55	73.32	0.7	0
10-Jul	30.07	20.43	68.86	0.6	0
11-Jul	31.68	22.39	67.24	0.4	0
12-Jul	27.7	22.71	72.19	0.5	0
13-Jul	26.95	19.98	67.87	0.6	0
14-Jul	22.88	15.77	78.77	0.6	0.2
15-Jul	24.78	16.71	79.16	1	0

**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

g. Soil Analysis



Stubton pH and  
organic matter 2022.F



Stubton soil analysis  
2022.PDF

h. Residue analysis for treatments 1, 2, 3 and 4 Stubton



Residue analysis DFB  
TRT1.pdf



Residue analysis DFB  
TRT2.pdf



Residue analysis DFB  
TRT3.pdf



Residue analysis DFB  
TRT4.pdf