Project title:	Investigation of the effect of cultivation timing on damage caused to vining peas (*Pisum sativum*) by bean seed fly larvae (*Delia platura*)
Project number:	FV 462
Project leader:	Dr Becky Howard, Processors and Growers Research Organisation (PGRO)
Report:	Annual report, September 2021
Previous report:	Annual report, September 2020
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Location of project:	Stubton, Lincolnshire
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Date project commenced:	1st April 2020

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr Becky Howard

R and D Manager

Processors and Growers Research Organisation

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GROWER SUMMARY

Headline

A period of at least 7 days between cultivation and drilling vining peas helped reduce damage to vining peas from bean seed fly larvae by 22%. Damage was reduced from 79.94% to 37.05% by leaving a period of 28 days, saving up to £550 in potential losses per hectare.

Background

There is currently no chemical control for bean seed fly larvae or adults and, following the removal of seed treatment options for vining peas the problem has increased considerably and some vining pea producer groups are experiencing high establishment losses. Later sown peas (late April onwards) are most affected, as the bean seed fly overwinters in soils as pupae and development and emergence are reliant on accumulated day degrees.

A survey of pea crops carried out in 2019 and 2020 by PGRO, Swaythorpe Growers and Stemgold Peas indicated that the period between spring cultivation and drilling peas was an important factor affecting damage to plants by bean seed fly larvae, with a period of around 14 days leading to reduced damage levels compared to cultivations taking place at the same time as drilling. This finding is supported by literature that cites conservation tillage and reduced cultivations to help manage damage to crops by bean seed fly larvae.

This trial aimed to determine whether cultivation timing may be used as a cultural method to help manage damage to crops by bean seed fly larvae, and the minimum period between cultivation and drilling to lead to optimum reduction of damage.

Summary

Monitoring traps containing plant volatile lures were found to provide a good indication of bean seed fly adult activity at the time of drilling and could be used to aid decision-making. Ideally this would be targeted to help determine location and date of drilling to avoid damage, and a day-degree model (currently not available but in development) would provide a valuable addition for monitoring and forecasting.

Cultivation treatments were as follows:

Table A. Treatments used at Stubton, Lincolnshire, including description and date of operations. All cultivations were undertaken using a power harrow.

Treatment	Description	Date of cultivation
1	Cultivated and drilled	27th April 2021
2	Cultivated 28 days before drilling	30th March 2021
3	Cultivated 20 days before drilling	7th April 2021
4	Cultivated 14 days before drilling	13th April 2021
5	Cultivated 7 days before drilling	20th April 2021

Vining peas were drilled at the site on 27th April 2021 and poultry layers mash added to plots to attract adult bean seed flies to the trial. The trial was rolled after drilling.

One assessment was carried out on 2nd June 2021 to evaluate seedling establishment and damage to seedlings by bean seed fly larvae.

The results showed that there were no statistically significant differences in seedling establishment between treatments. There were statistically significant differences in damage caused by bean seed fly between treatments on 2nd June (Table B). The results showed that a period of more than 7 days between cultivation and drilling peas reduced damage from bean seed fly larvae by between 22 and 42% (Table B).

Table B. Mean percentage of seedlings damaged by beans seed fly larvae and mean percentage of seedlings not emerged, recorded on 2nd June 2021.

	Treatment	Mean percentage of seedlings damaged by bean seed fly larvae recorded on 2nd June	Mean percentage seedlings not emerged on 2nd June
1	Cultivated and drilled 27th April 2021	79.94[a]	0.89
2	Cultivated 30th March 2021 (D-28 days)	37.05[c]	2.62
3	Cultivated 7th April 2021 (D-20 days)	54.87[b]	4.72
4	Cultivated 13th April 2021 (D-14 days)	45.14[bc]	6.84
5	Cultivated 20th April 2021 (D-7 days)	57.86[b]	6.09
	CV%	24.70	183.98
	LSD @ p = 0.05	11.38	0.80
	Probability	<0.001	0.5346

Financial Benefits

At the level of bean seed fly damage indicated in this trial, approximately 80% damage being the greatest damage to seedlings, there could be a saving to growers by the prevention of seedling losses of approximately £450 per hectare if this was reduced by 30%.

Action Points

Further study is required to confirm results. Results from 2020 and 2021 indicated that early cultivations help to reduce damage from bean seed fly. Because of the biological nature of the work, it must be borne in mind that different circumstances and conditions could produce different results.

SCIENCE SECTION

Introduction

Bean seed fly (*Delia platura*) affects more than 40 different host plants and is an important pest of peas, maize and beans. Hosts include *Phaseolus* beans, peas, broad beans, cucumber, melon, onion, pepper, potato, maize (alfalfa, cotton, strawberry and tobacco are secondary hosts) and 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 second generation of flies, which move to suitable feeding sites. There may be several overlapping generations per year, occurring from late spring until early autumn. Seed of later planted peas or beans is attacked during germination and larvae feed on newly planted seeds and seedlings, tunnelling into freshly imbibed seeds and the stems of small seedlings.

There is currently no chemical control for bean seed fly larvae or adults and, following the removal of seed treatment options for vining peas the problem has increased considerably and some vining pea groups are experiencing high losses at establishment. Later sown peas (late April onwards) are most affected, as the bean seed fly overwinters in soils as pupae and development and emergence are reliant on accumulated day degrees.

Increased tillage is associated with increased numbers of bean seed fly larvae, and minimum tillage may help to manage the pest (Hammond, 1997). Hammond (1997) described the results of a long-term experiment to determine the impact of no-tillage systems on the abundance of the pest *D. platura* in soya-maize cropping systems. In 9 out of 12 years of the study, the lowest level of *D. platura* adults was recorded in the no-till plots. The highest number of adults were collected in the areas where the soil was more disturbed by cultivations. Schmidt *et al*. (2017) also cited conservation tillage to reduce attack by bean seed fly, due to the generally higher levels of natural enemies recorded in no-till systems, and the fact that residual plant material is not incorporated into soils, bean seed flies being more attracted to incorporated, decomposing material. The use of reduced cultivations and stale seedbeds may therefore aid management of bean seed fly.

Surveys of pea crops carried out in 2019 and 2020 by PGRO, Swaythorpe Growers and Stemgold Peas indicated that the period between spring cultivation and drilling peas was an important factor affecting damage to plants by bean seed fly larvae, with a period greater than 10 days leading to reduced damage levels compared to cultivations taking place at the same time as drilling. This was seen broadly across the survey sites, with a few exceptions.

The second year of this trial aimed to further clarify whether cultivation timing may be used as a cultural method to help manage damage to crops by bean seed fly larvae, and the minimum period between cultivation and drilling to lead to optimum reduction of damage.

Materials and methods

A trial was established at Stubton in Lincolnshire (OS grid reference SK89375179) in March 2021. The trial design was a randomised complete block design, and the first cultivation took place on 30th March 2021, 28 days prior to drilling peas on 27 April 2021, using a power harrow. Cultivations took place at weekly intervals until the date of drilling (Table 1). Soil type was sandy loam.

Table 1. Treatments used at Stubton, Lincolnshire, including description and date of operations. All cultivations were undertaken using a power harrow.

Treatment	Description	Date
1	Cultivated and drilled	27th April 2021
2	Cultivated 28 days before drilling	30th March 2021
3	Cultivated 20 days before drilling	7th April 2021
4	Cultivated 14 days before drilling	13th April 2021
5	Cultivated 7 days before drilling	20th April 2021

The vining pea variety Amalfi was drilled using a Zurn small plot drill with Lemken double disc coulters on 27th April 2020, on the same day as the final cultivation treatment. Poultry layers mash was applied to all treatments along the rows to ensure a sufficient level of bean seed fly infestation, at a rate of 50g per metre. The trial was rolled following drilling.

An assessment was carried out on 2nd June 2021 to determine levels of damage to seed and seedlings as seed and stem tunnelling. Two rows of pea seedlings, each one metre long, were removed from each plot and assessed. The number of emerged and non-emerged seedlings were recorded, and each seedling evaluated for damage caused by bean seed fly larvae.

The trial received no maintenance treatments and was not harvested.

Data were analysed using Analysis of Variance in STAR® version 2.0.1 (International Rice Research institute, 2013).

Results

Figure 1. Bean seed fly damage to pea seed (seed tunnelling)

Establishment of seedlings was slow and variable at Stubton in 2021 due to cool weather following sowing (Table 3, Appendix A) and growth stage at the first assessment on 2nd June was variable with most plants at BBCH 13-15. Damage to seedlings was apparent mainly as damage to imbibed seed (Figure 1). There were no significant differences in the number of emerged seedlings between treatments or percentage of seedlings not emerged (Table 2). There were statistically significant differences in damage caused to seedlings by bean seed fly larvae when the assessment was carried out on 2nd June 2021 (Table 2, Figure 2). Pea seedlings in the plots that were drilled on the same day as cultivation had significantly higher levels of damage (79.94%) than all plots in which cultivation took place prior to drilling. Between the other treatments, extending the period to 7 days gave a significant benefit. Further extending the period to between 14 and 28 days gave considerable additional benefit (Table 2, Figure 2).

Table 2. Number of emerged seedlings per metre row, mean percentage seedlings not emerged and percentage of seedlings damaged by bean seed fly larvae at Stubton on 2nd June 2021 (BBCH growth stage 13-15). Means with the same letter are not significantly different from each other.

	Treatment	Mean number of emerged seedlings per metre row	Mean percentage of seedlings not emerged per metre row	Mean percentage of seedlings damaged by bean seed fly larvae
1	Cultivated and drilled 27th April 2021	13.50	0.89	79.94[a]
2	Cultivated 30th March 2021 (D-28 days)	12.75	2.62	37.05[c]
3	Cultivated 7th April 2021 (D-20 days)	12.38	4.72	54.87[b]
4	Cultivated 13th April 2021 (D-14 days)	12.12	6.84	45.14[bc]
5	Cultivated 20th April 2021 (D-7 days)	9.75	6.09	57.86[b]
	CV%	28.66	183.98	24.70
	F value	1.33	0.80	11.38
	Probability	0.2812	0.5346	<0.001

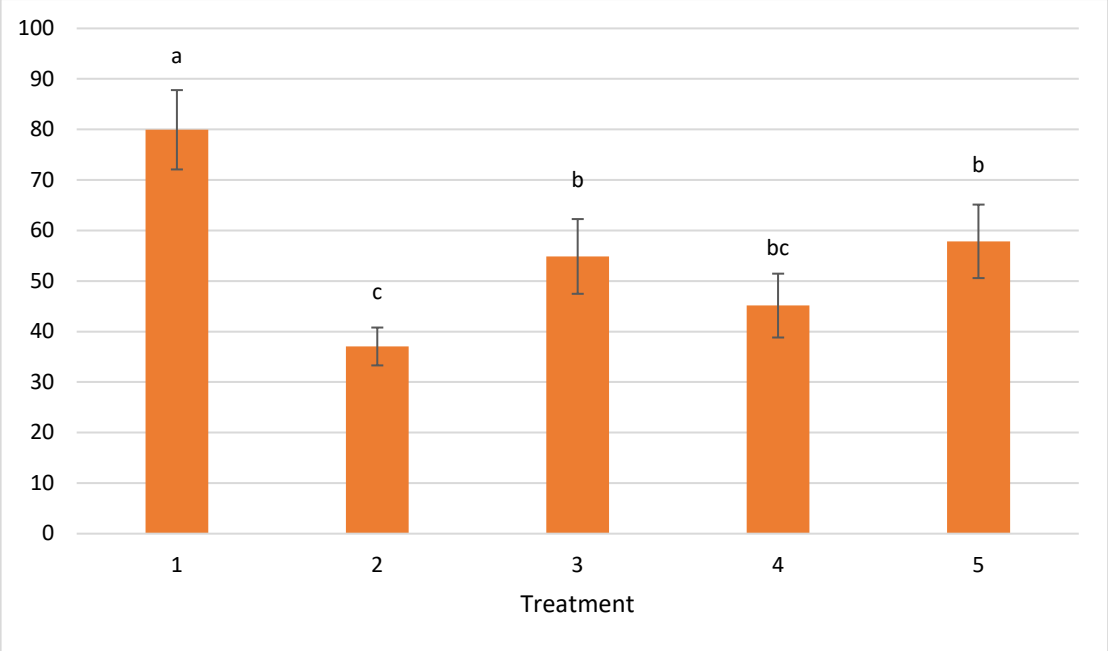

Figure 2: Percentage damage to plants caused by bean seed fly larvae, recorded on 2nd June 2021. Bars with the same letter are not significantly different. Error bars are standard error of the mean.

Discussion

The results from this trial strongly indicated that a cultural approach to management of bean seed fly damage in crops may be appropriate. Levels of larval damage to seed and seedlings were reduced in the treatments in which cultivations were carried out prior to the date of drilling, and in 2020 and 2021, the longer the period between cultivation and drilling, the greater the reduction in damage recorded at the early assessment. In 2021 a short period of 7 days between cultivation and drilling led to approximately 22% reduction in damage to imbibed seed and small seedlings compared to plots that were cultivated and drilled on the same day, and extending the period to 28 days led to a reduction of approximately 43% damage. On 2nd June the seedlings were at BBCH growth stage 13 to 15 and very vulnerable to attack from larvae and results from the assessment showed statistically significant differences. This is an encouraging message that even short periods between cultivation and drilling may offer growers the opportunity to better manage bean seed fly attacks in legume crops.

The trial in 2020 indicated that the level of foot rot may be linked to increased levels of bean seed fly larval attack to seedlings, although no foot rot was observed in 2021.

The trial should be repeated in 2022.

Conclusions

- It was beneficial to leave a period of at least 7 days between cultivation and drilling to help reduce levels of bean seed fly larval attack in peas, and extending this period to 28 days led to much greater benefit;
- Foot rot infection may be related to bean seed fly larval damage, but this hypothesis requires further testing;
- The trial should be repeated in 2022 due to difficult establishment conditions experienced in 2020 and 2021.

Knowledge and Technology Transfer

The Horticulture Strategic Centre for Field vegetables has helped to develop an iPhone and android application to report incidence of bean seed fly in all susceptible crops. This can be found in the PGRO App at Google and Apple stores – search for PGRO Pea and Bean Guide. The reporting application was made available in mid-March 2019. The application continues to be available to growers to report incidence of bean seed fly in crops. We strongly encourage growers to use the application so that activity can be monitored each year and over several years. This will help us to provide more accurate guidance about management of the pest for the future.

References

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Appendix A

Table 3. Stubton weather data for trial period 2021

Date	Mean air temp [°C]	Mean Relative humidity [%]	Total precipitation [mm]	Mean wind speed [m/s]	Mean soil moisture	Mean soil temp [°C]
31/03/2021	15.37	73.63	0.2	1.1	56.1	15.9
01/04/2021	7.24	96.9	0	3.6	55.5	12.1
02/04/2021	6.51	84.77	0	2.7	55.11	10.5
03/04/2021	5.91	89.65	0	2.1	54.88	9.7
04/04/2021	7.12	82.29	0	2.7	54.77	10.3
05/04/2021	5.32	54.53	0	4.4	54.3	10.4
06/04/2021	2.12	68	0	3.1	53.8	7.5
07/04/2021	3.19	56.27	0	2.4	53.62	7.4
08/04/2021	8.08	72.41	0	3.7	53.55	10.2
09/04/2021	6.92	88.25	0.2	2.1	53.45	10.2
10/04/2021	3.32	78.62	0.2	1.3	53.25	8.6
11/04/2021	1.97	91.79	0.6	1.4	52.92	7.4
12/04/2021	3.53	74.72	0.2	1	53.02	8.5
13/04/2021	5.4	64.01	0	1	52.97	10.2
14/04/2021	5.72	74.51	0	1.4	52.56	11.2
15/04/2021	4	77.56	0	1.2	52.05	9.6
16/04/2021	4.23	83.19	0	0.6	51.8	9.3
17/04/2021	5.62	68.68	0	0.8	51.69	10.9
18/04/2021	7.2	66.09	0	0.6	51.34	12.8
19/04/2021	7.94	80.08	0	0.9	50.89	13.8
20/04/2021	10.34	76.66	0	0.6	50.45	14.7
21/04/2021	8.06	78.82	0	2.4	49.78	13.4
22/04/2021	6.34	61.49	0	0.6	49.27	13.1
23/04/2021	9.3	62.95	0	0.8	48.63	14.5
24/04/2021	8.48	71.41	0	1.5	47.81	14.4
25/04/2021	6.73	79.4	0	2.1	46.97	12.7
26/04/2021	7.33	74.89	0	1.3	46.56	13.9
27/04/2021	7.75	90.34	2.2	1.3	45.99	12.5
28/04/2021	7.77	81.19	0	3.3	46.35	11.6
29/04/2021	4.55	95.23	0.8	1.5	45.97	9.5
30/04/2021	4.73	88.37	0.2	1.3	45.99	10

Table 3 continued

Date	Mean air temp[°C]	Mean Relative humidity [%]	Total precipitation [mm]	Mean wind speed [m/s]	Mean soil moisture	Mean soil temp [°C]
01/05/2021	6.42	83.77	0	1.4	45.83	11.3
02/05/2021	7.42	70.67	0	1.2	45.5	11.7
03/05/2021	8.06	98.14	9.4	3.6	48.17	10.7
04/05/2021	7.55	96.59	5.6	4.5	57.05	9.8
05/05/2021	6.31	83.71	0.4	2.3	58.53	9.7
06/05/2021	5.71	82.28	1.6	1.8	55.04	9.7
07/05/2021	7.69	78.98	0	1.5	54.64	10.8
08/05/2021	10.26	99.83	18.2	2.7	59.68	11.2
09/05/2021	15.25	95.29	0	3.6	59.53	15.2
10/05/2021	12.3	93.56	4.4	3.2	57.43	14
11/05/2021	10.37	98.21	5.6	1.3	60.08	13.4
12/05/2021	11.72	89.03	0	1.7	60.52	14.1
13/05/2021	11.73	83.64	0	2	56.81	15
14/05/2021	9.46	97.7	0	1.3	54.24	13.5
15/05/2021	10.34	99.85	4.4	0.5	53.49	13.7
16/05/2021	11.34	96.03	1.8	1.1	57.32	14.6
17/05/2021	10.71	98.93	2.6	1.4	56.75	14.5
18/05/2021	11.28	85	0	1.5	55.71	14.4
19/05/2021	11.96	79.22	0.6	1.3	52.7	15.3
20/05/2021	9.67	99.86	7.6	2	50.6	13.2
21/05/2021	11.06	99.84	16.6	4.6	58.39	12.5
22/05/2021	9.11	97.63	0.6	2	62.3	12.1
23/05/2021	9.19	92.37	5.4	2.7	59.47	11.4
24/05/2021	9.29	97.81	12.2	1.2	63.59	12.4
25/05/2021	10.17	95.64	1.4	2.6	62.94	12.3
26/05/2021	10.16	99.83	8.2	1.6	62.62	12.4
27/05/2021	11.83	98.04	0	0.5	63.98	14.4
28/05/2021	14.8	83.92	0	0.5	60.45	16.3
29/05/2021	15.91	80.64	0	0.5	57.23	17.9
30/05/2021	12.44	86.96	0	1.5	53.83	17.3
31/05/2021	14.05	89.46	0	1.4	50.93	18.1

Table 3 continued

Date	Mean air temp[°C]	Mean Relative humidity [%]	Total precipitation [mm]	Mean wind speed [m/s]	Mean soil moisture	Mean soil temp [°C]
01/06/2021	15.52	83.13	0	1.5	48.23	18.9
02/06/2021	17.07	84.71	0	2	45.65	19.8
03/06/2021	17.14	95.94	0.2	1	43.85	20.2
04/06/2021	15.03	86.54	0	0.6	42.62	19
05/06/2021	17.19	75.9	0	0.6	41.83	20
06/06/2021	16.37	99.88	0.2	0.7	40.71	19.8
07/06/2021	17.43	92.89	2.6	0.9	40.9	19.4
08/06/2021	17.38	78.15	0	0.9	40.43	20
09/06/2021	18.79	79.39	0	1.4	39.42	20.8
10/06/2021	18.97	93.93	0	1.6	38.43	20.9
11/06/2021	18.88	91.73	0	2.4	37.62	21
12/06/2021	16.8	75.59	0	1.4	36.66	20.6
13/06/2021	18.62	84.52	0	0.6	35.8	21.1
14/06/2021	18.83	84.2	0	1.6	35.15	22
15/06/2021	15.76	76.63	0	0.6	34.35	20.6
16/06/2021	20.48	74.79	0	1	33.83	22.4
17/06/2021	16.75	99.82	4	1	34.89	20.5
18/06/2021	13.27	99.79	17.4	1.8	47.29	17.7
19/06/2021	13.37	99.84	0.2	1.1	58.98	16.8
20/06/2021	12.73	99.82	3.6	1.6	59.35	16.2
21/06/2021	12.76	97.5	0	1.8	55.93	15.9
22/06/2021	12.78	84.63	0	1.6	52.76	15.7
23/06/2021	14.81	77.62	0	0.6	49.13	16.7
24/06/2021	16.97	99.79	0	0.7	45.34	18.2
25/06/2021	14.02	99.8	8.6	1.5	50.53	17.2
26/06/2021	14.39	99.84	0	1.6	55.96	17
27/06/2021	15.09	99.82	0.2	1.9	52.53	17.3
28/06/2021	13.86	99.81	0	1.5	49.9	16.4
29/06/2021	15.16	93.77	1.2	1.2	48.04	17.2
30/06/2021	13.56	99.86	0	1.4	44.95	16.5