EVALUATION OF CULTURAL TECHNIQUES FOR THE MANAGEMENT OF BEAN SEED FLY DAMAGE IN VINING PEAS 2019-2020

Becky Howard

Bean Seed Fly – Background

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.

PGRO, with Swaythorpe Growers and Stemgold Peas, carried out large-scale field surveys in 2019 and 2020 to determine whether different sowing dates, cultivations and drill types may lead to different levels of damage in vining peas. There is some support in literature to indicate that reduced cultivations may lead to lower levels of damage. In addition to the work summarised below being carried out by PGRO with Swaythorpe Growers and Stemgold Peas, PGRO carried out a trial in Lincolnshire to investigate the use of different cultivation timings to reduce damage, funded by AHDB in the Horticulture Strategic Centre for Field Veg program (FV462).

PGRO is co-sponsoring with AHDB a PhD student at Warwick Crop Centre (University of Warwick Wellesbourne campus) with Rosemary Collier, that will further investigate the lifecycle of the bean seed fly, aim to produce an accurate prediction model to aid forecasting of peak activity, and carry out further investigation of cultural techniques (cultivations and land preparation) for improved management. The PhD started on 01 October 2019 and the student will work with PGRO to gather more data from field-scale sites.

Introduction:

Following high levels of damage to vining peas in the Yorkshire and Lincolnshire Wolds during 2017 and 2018, a program of survey work was agreed between Swaythorpe Growers Ltd., Stemgold Peas and PGRO. The aim was to gather preliminary data to evaluate the effects of using different sowing dates, drills and cultivation techniques on damage by bean seed fly to vining pea crops. This was done using large scale trials, with a variety of unreplicated field operations (Tables 1 to 4).

Methods:

Table 1: *Location of all sites in 2019.*

Site		Grid Reference
Yorkshire 2019	T1 Beverley	TA 01414162
	T2 Tibthorpe	SE 91435593
	T3 Wold Newton	TA 05697344
	T4 Wold Newton	TA 05697344
	T5 North Frodingham	TA 11655112
	T6 North Frodingham	TA 12315101
	T7 Middleton on the Wolds	SE 92844906
Lincolnshire 2019	Swaby F1	TF 37777829
	Swaby F2	TF 38077759
	Swaby F3	TF 38087719
	Swaby control	TF 37517769
	Welton-Le-Wold	TF 25488664
	Binbrook	TF23049468

Table 2: *Field operations at all sites in Yorkshire and Lincolnshire in 2019 – all crops were vining peas*.

Site	Variety	Drilling date	Drill type	Previous treatment	Establishment method
T1 Beverley (Yorkshire)	Ashton	1st June 2019	Vaderstad Rapid	Ploughed and pressed	Conventional
T2 Tibthorpe (Yorkshire)	Waverex	3rd May 2019	Vaderstad Rapid	Vaderstad NZ X 2	Conventional Not rolled
T3 Wold Newton A (Yorkshire)	Anubis	25th April 2019	Claydon Hybrid	Grazed off cover crop	Direct drilled Rolled
T4 Wold Newton B (Yorkshire)	Anubis	25th April 2019	Claydon Hybrid	Grazed off Cover Crop - Plough Power Harrow	Conventional Rolled
T5 North Frodingham A (Yorkshire)	Dancer	9th June 2019	Pottinger Terrasem	Sprayed off Cover Crop	Direct drilled Not rolled
T6 North Frodingham B (Yorkshire)	893	5th June 2019	Pottinger Terrasem	Ploughed & Rolled	Conventional Not rolled
T7 Middleton on the Wolds (Yorkshire)	Ashton	14th May 2019	Gro Mobile plot drill	Rexious Twin	Conventional Not rolled

Swaby F1 (Lincolnshire)	Realm	23rd April 2019	Horsch Avatar/ Sumo (strips)	TopDown cultivator Aug/ Sept 2018	Min-till/ Not rolled
Swaby F2 (Lincolnshire)	Realm	23rd April 2019	Sumo	TopDown cultivator Aug/ Sept 2018/ Subsoil Sept 2018	Min-till/ Not rolled
Swaby F3 (Lincolnshire)	Realm	23rd April 2019	Sumo		Direct drilled
Swaby control (Lincolnshire)	Realm	26th April 2019	Vaderstad	Vaderstad Rexius Press cultivator 15th April 2019	Conventional/ rolled
Welton-Le-Wold (Lincolnshire)		14th May 2019		Ploughed 15 October 2018/ Spring Tine Harrow 20 March 2019/ NZ Tine cultivator 12th May 2019	Conventional/ rolled
Binbrook (Lincolnshire)		7th May 2019		Ploughed 23 October 2018/ Simba CultiPress 23rd April 2019	Conventional/ not rolled

Table 3: *Location of all sites in 2020.*

Site		**Grid Reference**
Yorkshire 2020	T1 Sledmere	SE 93506716
	T2 Huggate	SE 91435701
	T3 Middleton in the Wolds	SE 93084920
	T4 Market Weighton	SE 92064166
	T5 Beverley	TA 01564209
Lincolnshire 2020	L1 Burgh on Bain	TF 20548638
	L2 Market Stainton	TF 22467989
	L3 Walmsgate	TF 36937801

Table 4: *Field operations at all sites in Yorkshire and Lincolnshire in 2020 – all crops except T3 Yorkshire were vining peas*.

Site	**Variety**	**Drilling date**	**Drill type**	**Previous treatment**	**Establishment method**
T1 Sledmere (Yorkshire)	Trophee	24th April 2020	Vaderstad Rapid	Ploughed mid-Feb, Vaderstad NZ and rolled 1st week April,	Conventional/ rolled
T2 Huggate (Yorkshire)	Tendrilla	2nd May 2020	Vaderstad Rapid	Ploughed, pressed 27th April	Conventional/ rolled post-emergence
T3 Middleton on the Wolds (Yorkshire)	Listra broad beans	24th April 2020	Vaderstad Rapid	Ploughed, pressed 2nd April, power-harrowed pre-drilling 23rd April	Conventional/ rolled
T4 Market Weighton (Yorkshire)	Ashton	19th May 2020	Horsch Pronto	Spring ploughed last week of April/ Vaderstad NZ 18th May	Conventional/ rolled
T5 Beverley (Yorkshire)	Amalfi	29th May 2020	Vaderstad Rapid	Spring ploughed Feb/ pressed mid-April/ power-harrowed 26th May	Conventional/ rolled
L1 Burgh-on-Bain (Lincolnshire)		6th May 2020	Combination drill	Ploughed September 2019/ Power-harrow combination drill	Conventional/ rolled
L2 Market Stainton (Lincolnshire)		20th April 2020	Combination drill	Ploughed late January/ rolled pre-drilling/ power-harrow combination drill	Conventional/ rolled pre-drilling
L3 Walmsgate (Lincolnshire)		2nd May 2020	Horsch drill	Ploughed September 21st 2019/ Light Rexius cultivation 8th April 2020	Conventional/ not rolled

Pest monitoring:

Attractant traps were located at the each of the sites, consisting of yellow sticky cards with plant volatile lures containing chemical constituents of onion pulp, obtained from AgBio, Inc. US, http://www.agbio-inc.com/seedcorn-and-onion-maggot.html, to give an indication of the size of adult bean seed fly populations at each site. These were monitored weekly during the period of activity of adult bean seed flies.

Damage to crops caused by bean seed fly larvae:

Assessments were carried out by counting the number of plants per metre length along a row, or from 1/3 m^2 quadrat, followed by digging the plants out from each row/ quadrat and assessing the stem base and seeds for damage. This was done at between 25 and 100 points in each area or field depending on the size of the field. Assessments were carried out between 21st May 2019 and 27th June 2019, and between 20th May 2020 and 15th June 2020, three to four weeks after drilling. Further assessments were carried out to evaluate foot rot at some sites. Results are reported as percentage damage by bean seed fly larvae, and as percentage plants infected with foot rot. Results are demonstrated graphically with some interpretation given below.

Results:

Trap records Yorkshire and Lincolnshire 2019

The numbers of adults recorded in sticky traps in Yorkshire between 9th May and 22nd July 2019 are shown in Figure 1. Highest numbers of adults were recorded at Middleton on the Wolds during the first two weeks following drilling, between 17th and 24th May. Very high numbers were also recorded at the direct drilled site at North Frodingham between 9th and 24th May, at Tibthorpe on 24th May and at Wold Newton on 17th May 2019. Sites at North Frodingham were drilled in early June which followed peak trap catches, Tibthorpe on 3rd May, prior to peak catch, and Wold Newton was drilled on 25th April, 22 days prior to any adults being recorded in traps.

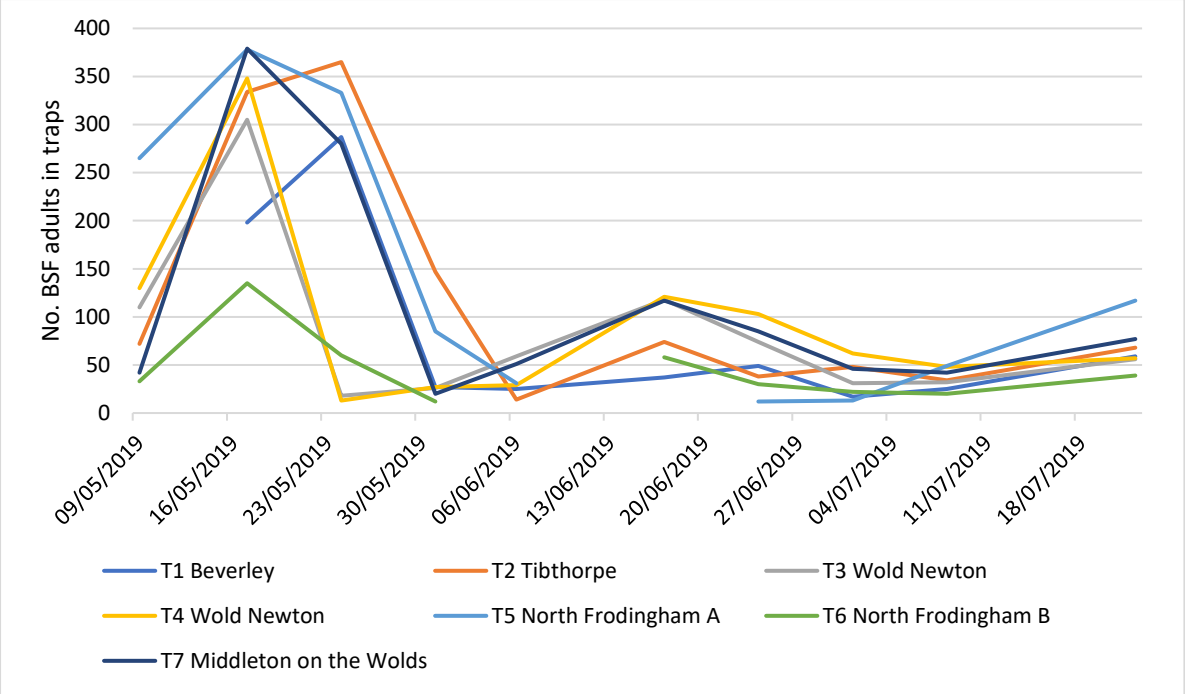

Figure 1: *Number of adult bean seed flies recorded in sticky traps in Yorkshire between 9th May and 22nd July 2019.*

The numbers of adults recorded in sticky traps in Lincolnshire between 23 April and 15 July 2019 are shown in Figure 2. Highest numbers were recorded at Binbrook during the first three weeks following planting, and at Swaby during the middle of June, well after drilling in late April. At Welton-le-Wold, numbers peaked towards the end of June. Plants are affected by the larvae at the early crop growth stage and more developed crops are not at risk from further damage.

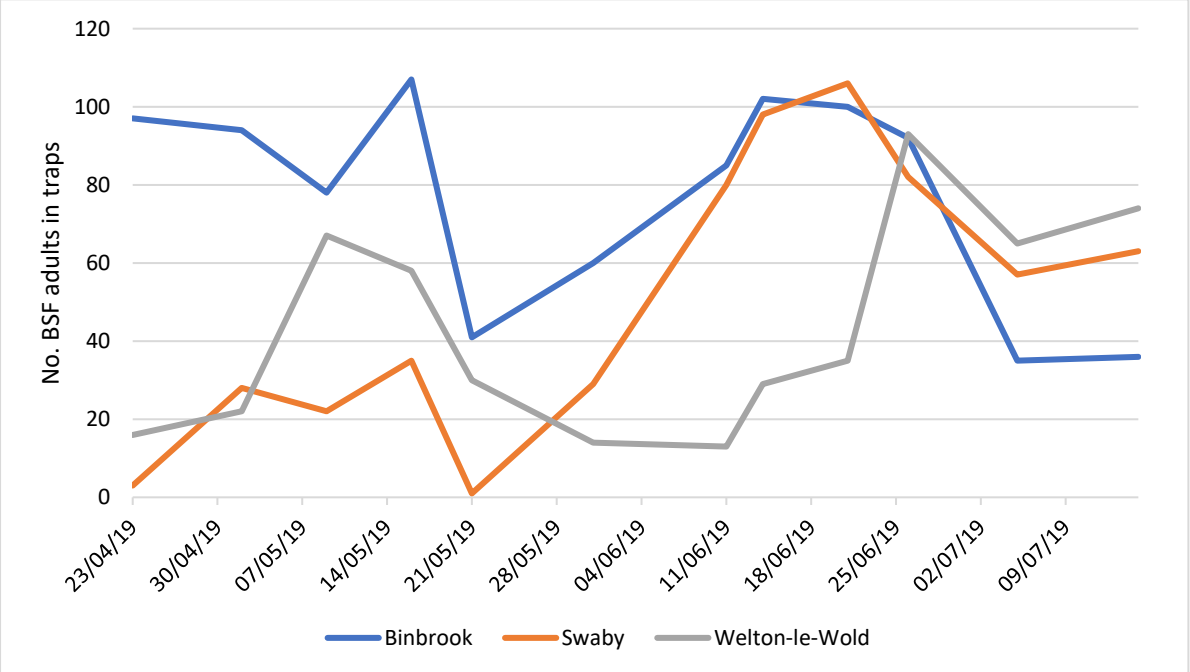

Figure 2: *Number of adult bean seed flies recorded in sticky traps in Lincolnshire between 23rd April 2019 and 15th July 2019.*

Trap records Yorkshire and Lincolnshire 2020

The numbers of adults recorded in sticky traps in Yorkshire between 16th April and 9th July 2020 are shown in Figure 3. Highest numbers of adults were recorded at Market Weighton on 30th April, approximately 3 weeks before drilling on 19th may. Medium numbers were recorded at other sites, Beverley having the second highest peak in adult activity. Peak adult activity occurred prior to drilling at all sites apart from Sledmere and Huggate, where low numbers of adults were caught, peaking during mid-May. At these two sites, damage levels were much lower (Figure 7).

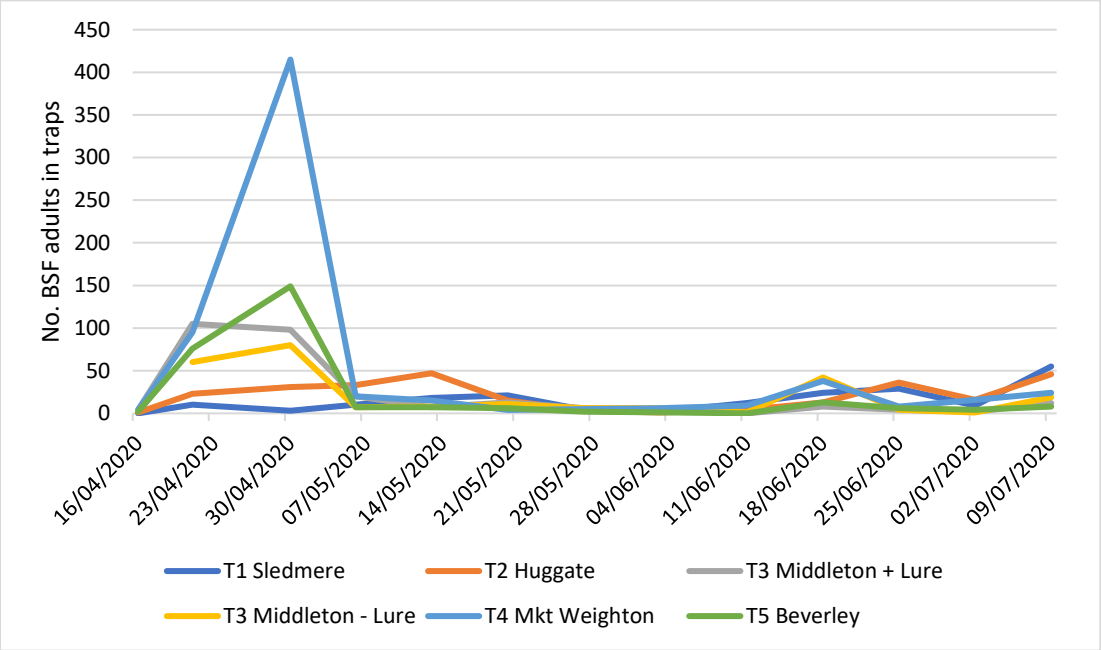

Figure 3: *Number of adult bean seed flies recorded in sticky traps in Yorkshire between 16th April and 9th July 2020.*

There were two clear peaks in adult activity in Lincolnshire in 2020, one during mid-April and the second peak during mid-late June (Figure 4). The first peak occurred prior to drilling at Burgh on Bain and Walmsgate and very close to drilling date at Market Stainton. Although low levels of damage were recorded at Walmsgate in 2020 (Figure 7), this had the highest recorded adult peak in traps in April (Figure 4).

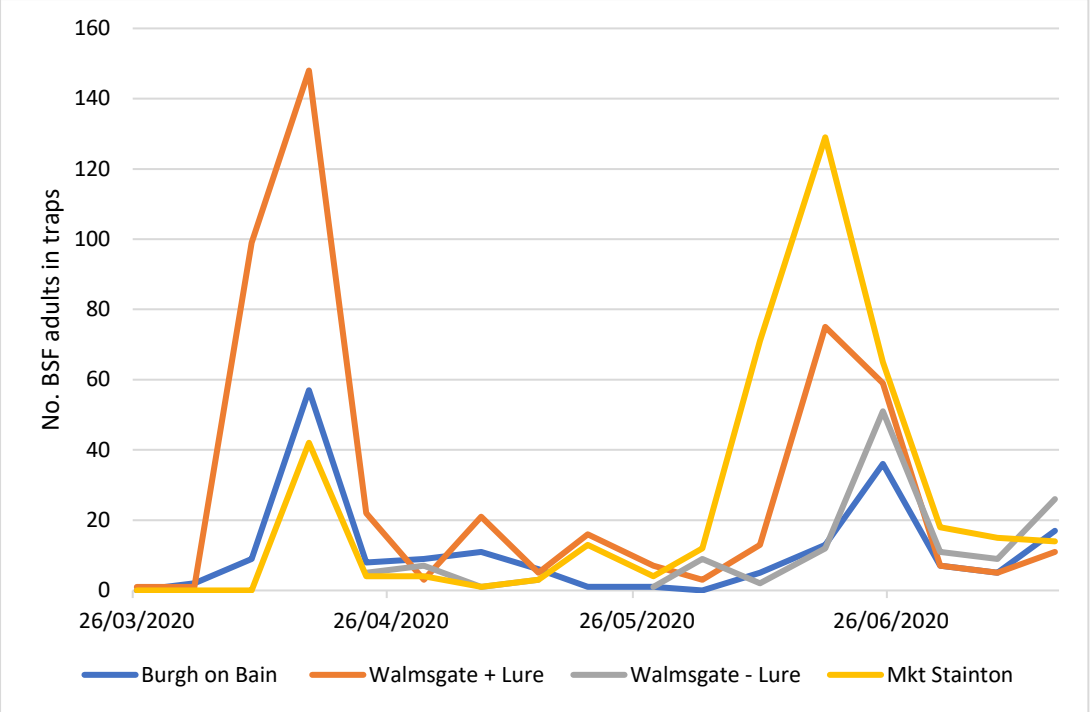

Figure 4: *Number of adult bean seed flies recorded in sticky traps in Lincolnshire between 26th March 2020 and 16th July 2020.*

Results from the assessments carried out at all sites in both years are shown in Figures 5 to 10.

There were differences in levels of damage between the sites in Yorkshire and Lincolnshire in 2019 (Figures 5 and 6), and this is likely to be the result of drilling timing related to the time of peak adult presence at each site (Figure 8).

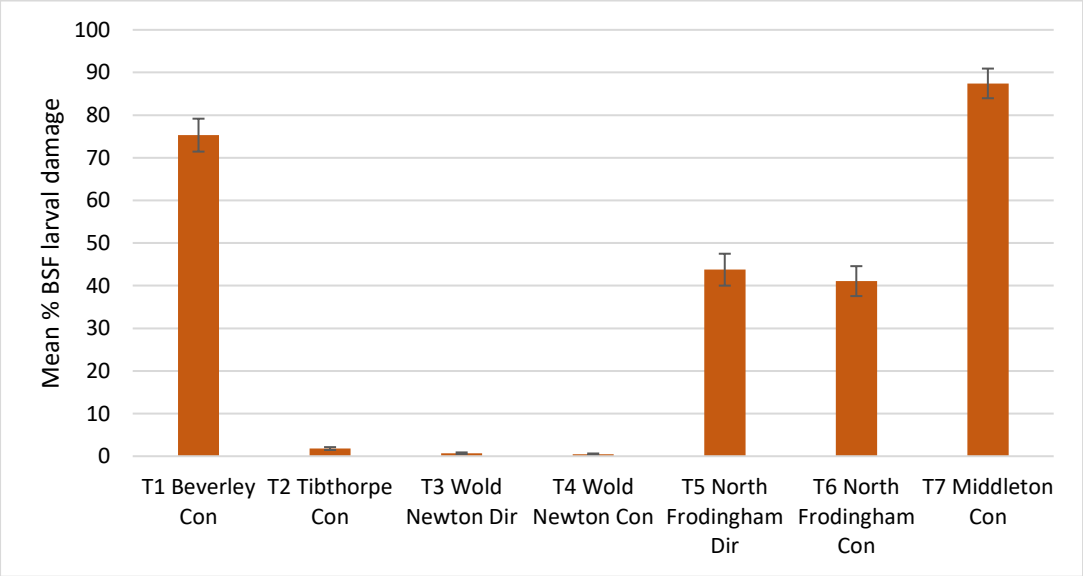

Figure 5: *Mean percentage damage caused by bean seed fly larvae at all sites in Yorkshire, recorded between 29th May and 27th June 2019. Error bars show standard error of the means.*

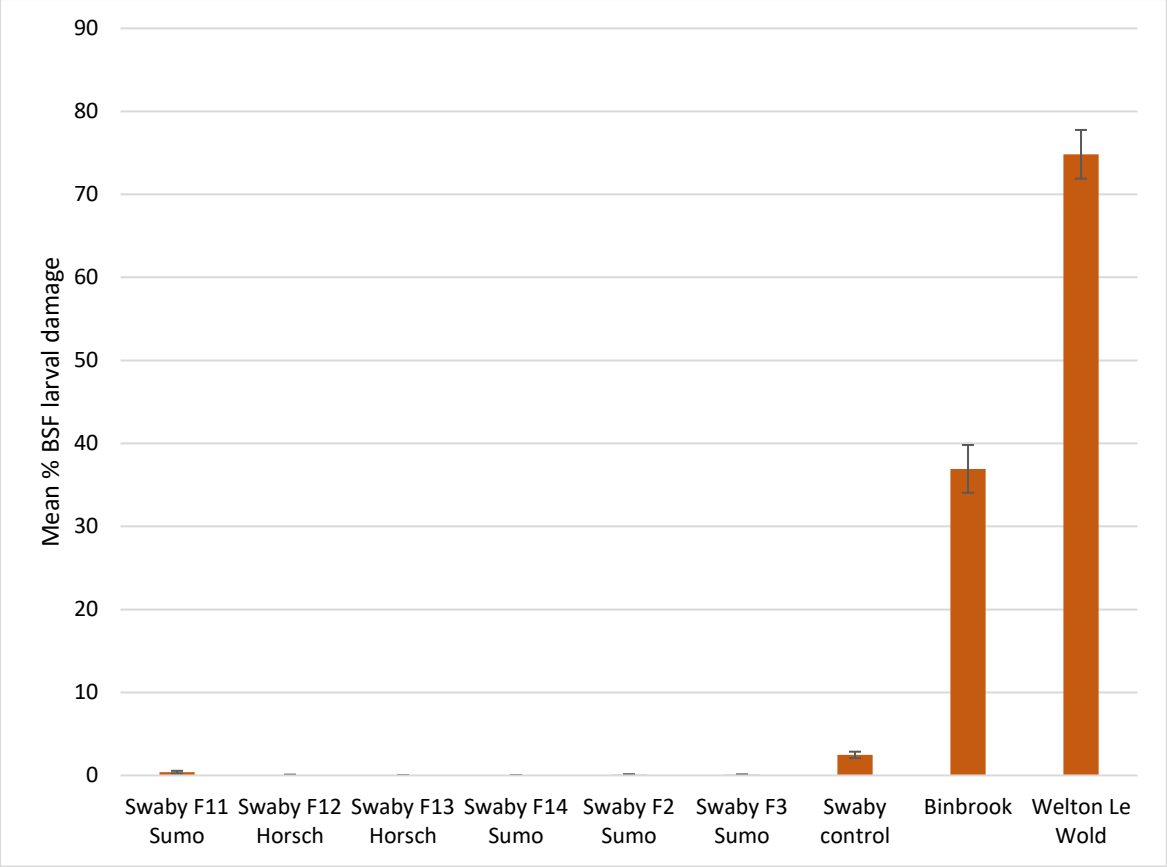

Figure 6: *Mean percentage damage caused by bean seed fly larvae at all sites in Lincolnshire, recorded between 21st May and 26th June 2019. Error bars show standard error of the means.*

There were also differences in levels of damage between sites in Yorkshire and Lincolnshire in 2020 (Figure 7) which also appeared to be related to proximity of drilling date to peak adult activity (Figure 8).

Figure 8 shows the comparison of damage levels with the period between cultivation date and drilling date, and peak adult activity and drilling date. It can be observed that the damage level at each site results from a mixture of both factors, so that when peas and beans were drilled prior to the peak period of adult activity there were clearly lower levels of damage (as can be seen towards the left part of Figure 8). Where drilling occurred after peak adult activity, damage was higher (towards the right part of Figure 8). However, it can also be observed that longer periods between cultivations and drilling gave a trend for lower levels of damage and when peas were drilled on the same day as cultivations, the level of damage was higher. This can be seen more clearly in Figures 9 and 10, where highest levels of damage occurred when drilling took place 10 days either side of peak activity (Figure 9) and damage declined when long periods between cultivation and drilling occurred (Figure 10).

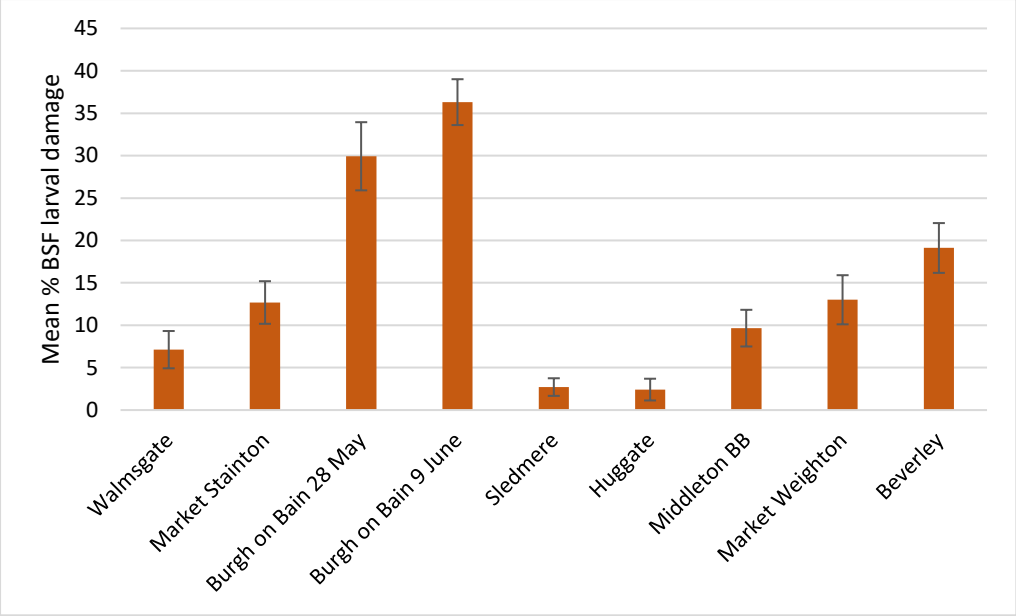

Figure 7: *Mean percentage damage caused by bean seed fly larvae at all sites in Lincolnshire and Yorkshire, recorded between 20th May and 9th June 2020. Error bars show standard error of the means.*

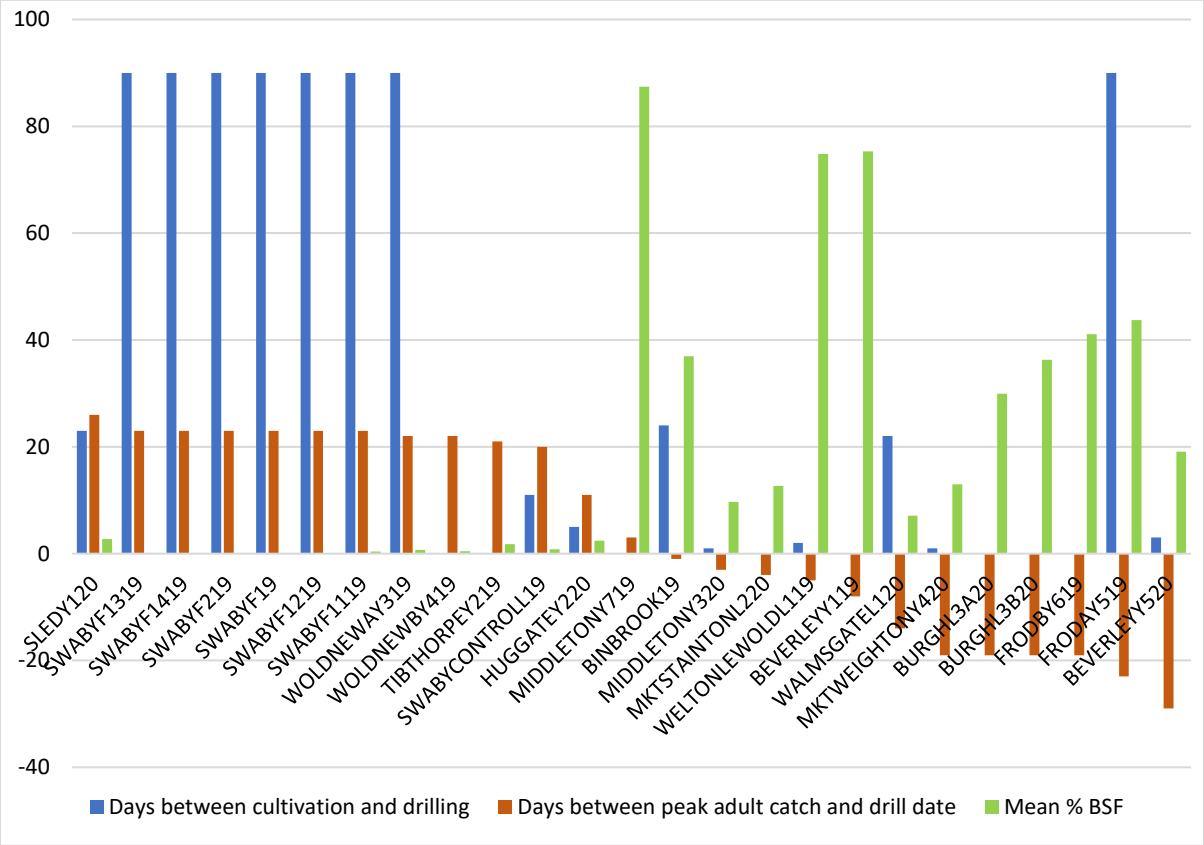

Figure 8: *Mean percentage damage at each site compared to the period between peak adult presence in traps and period between cultivation and drilling date in Yorkshire and Lincolnshire in 2019 and 2020. Bars below the x-axis represent those sites that were drilled after peak adult presence occurred.*

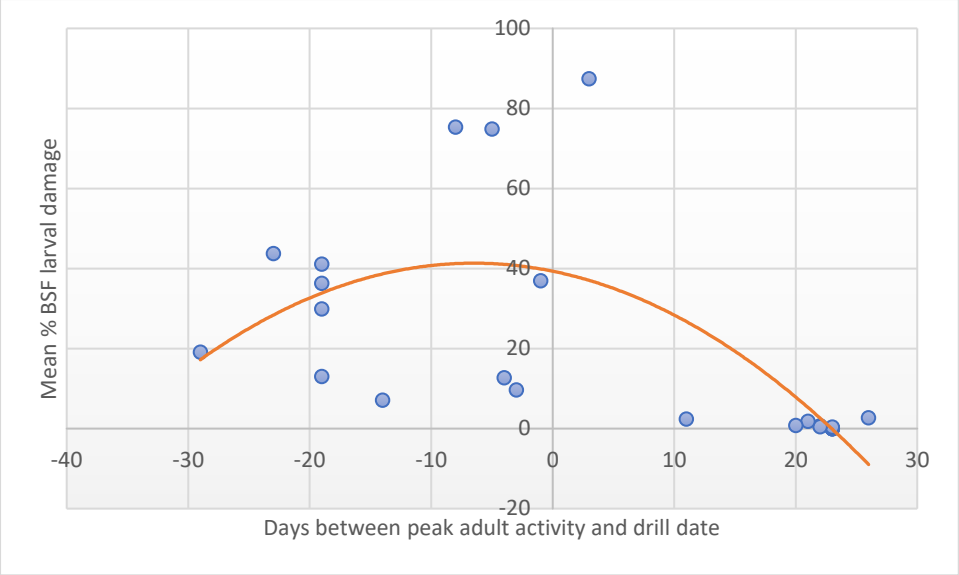

Figure 9: *Mean percentage damage compared to the period between peak adult presence in traps and drilling time at all sites in Yorkshire and Lincolnshire in 2019 and 2020. Points below zero on the x-axis represent those sites that were drilled after peak adult activity occurred.*

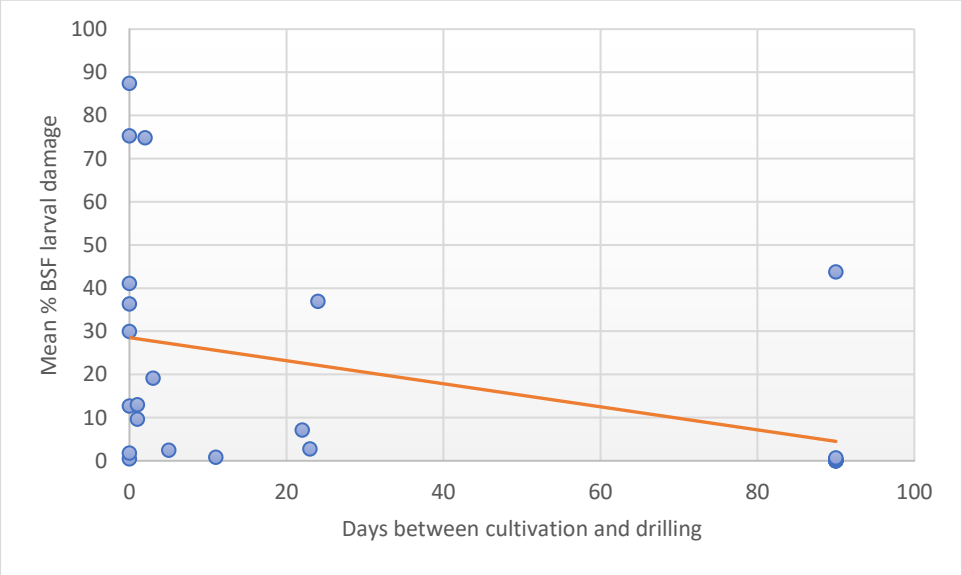

Figure 10: *Percentage bean seed fly damage compared to the period between cultivation and drilling date for all sites in Yorkshire and Lincolnshire in 2019 and 2020.*

Foot rot infection caused by soil-borne pathogens was recorded at some of the sites (Figure 11). There does not appear to be a strong relationship between bean seed fly larval damage and foot rot infection over the two years, although there is a trend towards higher levels of foot rot where higher levels of bean seed fly damage were recorded. There did not appear to be any obvious trends in bean seed fly larval damage to seedlings in relation to drill type or whether rolling was undertaken, and the use of cover crops in the rotation did not appear to have a detrimental effect on damage, although data for these effects are limited.

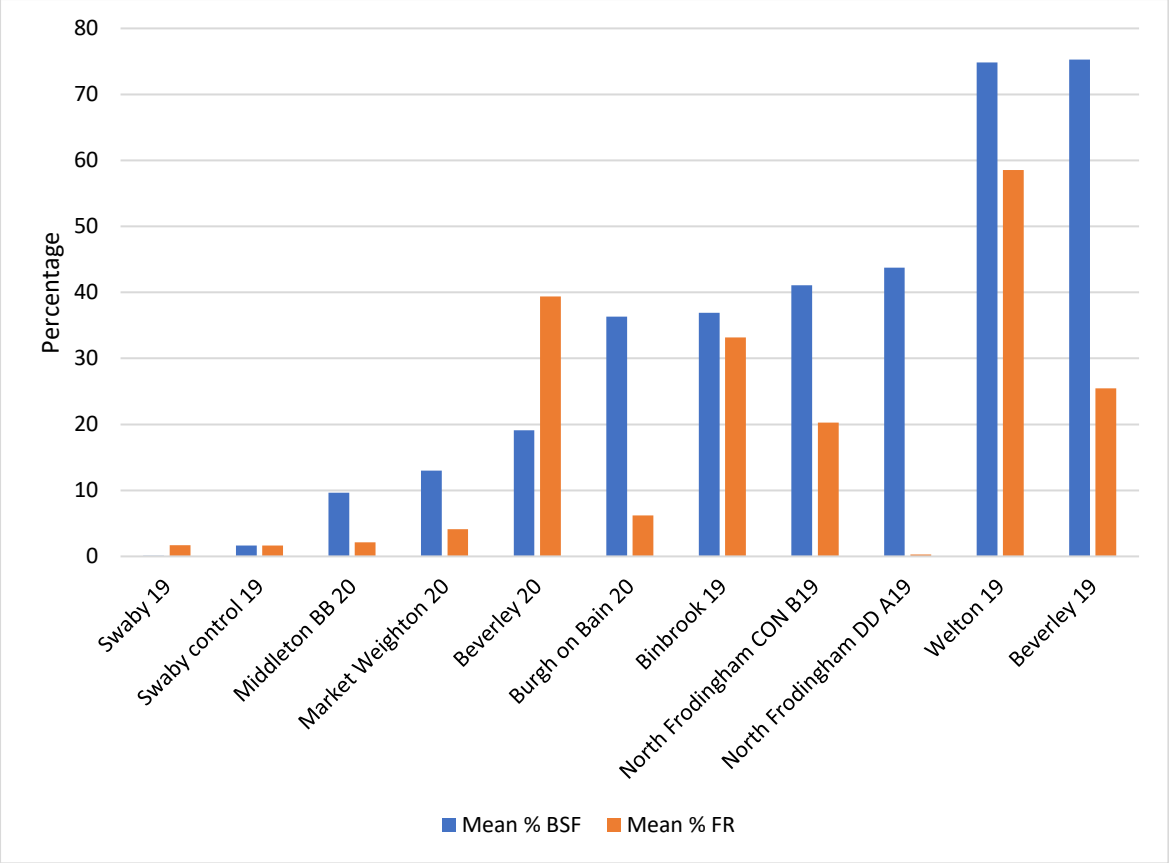

Figure 11: *Mean percentage plants with foot rot infection in root system when removed from the ground compared to damage from bean seed fly larvae at sites evaluated in Yorkshire and Lincolnshire in 2019 and 2020.*

Discussion:

Trap records:

Monitoring trap records showed variation between sites. In Yorkshire in 2019, the first peak catch occurred in mid to late-May and very high numbers of adults, up to 350 at some sites, were recorded in traps (Figure 1). A smaller second peak occurred in mid-June when around 100 adults were recorded at some sites. Adult numbers were lower overall in Lincolnshire, peaking slightly earlier in mid-May and again in mid to late-June, with highest numbers recorded at around 100 per trap at some sites (Figure 2).

In 2020, peaks in adult numbers were recorded earlier than in 2019. In Yorkshire the first peak occurred in late April with no significant second peak. Highest recorded numbers were between 100 and 450 adults per trap in Yorkshire (Figure 3). The site at Walmsgate had higher numbers of adults during the first peak, and the site at Market Stainton had higher numbers at the second peak. In Lincolnshire the first peak occurred slightly earlier in mid-April, again with lower numbers of adults recorded, between 40 and 150 per trap at highest levels. A second peak occurred in mid to late June, again with highest numbers at between 30 and 130 per traps (Figure 4).

Damage to crops:

Despite the differences in numbers of adults recorded in traps between Yorkshire and Lincolnshire in 2019, levels of damage to crops reached similarly high levels at some sites (Figures 5 and 6). Overall levels of damage recorded were lower in 2020 than in 2019, and despite higher numbers of adults being recorded in traps in Yorkshire compared to Lincolnshire, damage to crops was roughly similar for both regions (Figure 7).

There seems to be a combined effect of proximity of drilling date to peak adult presence and cultivation date on crop damage from bean seed fly larvae (Figure 8). Crops drilled before peak adult presence avoided the highest levels of damage, as would be expected. Imbibing seeds and young seedlings are most at risk from damage and therefore if peas were drilled well before peak adult activity, damage levels were very low to zero. If drilled in the period 10 days before and 10 days after peak adult activity, damage levels were highest (Figures 8 and 9). Overall, there was a trend for reduced damage when longer periods occurred between cultivation and drilling, but this was not always the case (Figures 8 and 10). A small plot trial carried out at Stubton in Lincolnshire showed that leaving a period of between 21 and 28 days between cultivation and drilling led to significantly reduced levels of larval damage in peas compared to peas drilled on the same day as cultivations took place. A report from this trial is available (FV462).

Foot rot infection:

Although not all of the sites were evaluated for foot rot infection, the direct drilled site at North Frodingham in 2019 had lower levels of foot rot infection than the conventionally drilled sites that were evaluated, despite having similar levels of larval damage to seedlings. This was further investigated in 2020 and there was a general trend for higher levels of foot rot when levels of bean seed fly damage were higher (Figure 11), although this still requires further investigation. There are multiple factors that lead to development of foot rot in peas, and bean seed fly damage is only one of these. Any damage or stress to plants, as well as high pathogen burden in soils. will lead to potential for increased levels of foot rot.

Final summary:

The data from these unreplicated large-scale field surveys suggest that the period between drilling and peak adult bean seed fly presence is of primary importance, and that cultivation date can help to manage the pest where drilling date falls into the risk period around peak activity. Drill type and rolling were not found to have a significant effect.

The survey should continue for a third year to include the following:

The effects of cultivation timing prior to drilling on bean seed fly larval damage to seedlings, preferably using replicated strips;

The influence of drilling depth on bean seed fly larval damage to seedlings, preferably using replicated strips;

The influence of bean seed fly damage on foot rot infection in peas.

The results of the survey so far also indicate the importance of being able to predict the date of peak activity, so that drilling date in areas that are highly affected can be modified appropriately.