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Autumn survey of wheat bulb fly incidence 2016

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1. Abstract

All cereals, except oats, can be attacked by wheat bulb fly. Eggs are laid in late summer in bare soil following fallows or early harvested crops, such as vining peas, particularly if fields are cultivated between mid-July and mid-August. Fields cropped with root crops, such as sugar beet, potatoes and onions, are also favoured as egg-laying sites, as the pest can access bare soil between the rows. Wheat bulb fly is most prevalent in eastern England and north-eastern England. Egg numbers can be estimated by soil sampling and related to threshold levels of 250 eggs/m^2 (2.5 million eggs/ha) for crops sown in September and October, or 100 eggs/m^2 (1.0 million eggs/ha) for crops sown from November onwards.

The specific objectives of the project are:

1. To measure the incidence of wheat bulb fly each autumn in the infested areas
2. To forecast the need for seed treatment

A total of 30 fields were sampled in September 2016 in areas prone to wheat bulb fly, with 15 in eastern England and 15 in northern England. The sites were chosen to represent some of the main preceding crops, leading to a risk of wheat bulb fly damage in each area.

In autumn 2016, one field of the 30 surveyed (3%) was considered at high risk, containing egg numbers greater than 250/m^2, seven fields (23%) were considered at moderate risk, containing egg numbers between 100/m^2 and 249/m^2 and 22 fields (74%) were considered at low risk, containing egg numbers less than 100/m^2. In total, one field (3%) was above the 250 eggs/m^2 threshold for crops sown in September and October. At 3%, the overall risk in 2016 is the equal lowest recorded since monitoring began in 1984. It is possible that as the winter wheat harvest was ahead of that in 2015 there was less time for saprophytic fungi to develop in cereal ears, which in turn meant less food for adult wheat bulb fly females resulting in them laying fewer eggs. Average egg numbers in the north were similar to those in the east with 90 eggs/m^2 in the east and 89 eggs/m^2 in the north

One field in the east had egg numbers above the 250 eggs/m^2 threshold, whereas none were above this level in the north. Over all sites, the highest risk was after onions, with a mean of 212 eggs/m^2. The next highest risk was after potatoes, with 123 eggs/m^2.

Late-sown (November onwards) or slow developing crops are at greater risk from wheat bulb fly than those that are early sown (September/October) due to slower tiller development. As a result, a lower threshold of 100 eggs/m^2 or 1 million eggs/ha is applicable for these crops. In both the north of England and the east of England 27% of sites were above this level and would benefit from a seed treatment.

2. Introduction

All cereals except oats can be attacked by wheat bulb fly. Eggs are laid in late summer in bare soil following fallows or early harvested crops, such as vining peas, particularly if fields are cultivated between mid-July and mid-August. Fields cropped with root crops, such as sugar beet, potatoes and onions, are also favoured as egg-laying sites, as the pest is able to access bare soil between the rows (AHDB, 2016). The pest is most prevalent in eastern England and north-eastern England. In outbreak years, more widespread damage occurs.

Eggs are laid in late July and August in England and up to mid-September in Scotland and remain dormant throughout late autumn and early winter. The larvae hatch between January and March. Soon after hatching, they invade shoots of cereal crops and the attacked shoots eventually die back to show ‘deadheart’ symptoms of damage.

The level of risk each year fluctuates greatly, due mainly to July and August rainfall (Young & Cochrane, 1993) and the harvest dates of the previous wheat crops. The longer crops remain in the ground, the longer adult flies have to feed on saprophytic fungi within the cereal ears and mature their eggs. Incidence generally increases following a wet harvest period, such as in 2004, and is lowest after a hot, dry summer, such as in 1995. The proportion of fields having an egg count greater than the 250 eggs/m² threshold ranged from 3% to 44% in the period 1984–1999 (Oakley & Young, 2000) and from 3% to 50% between 2000 and 2015 (Figure 1).

The wheat harvest 2016 started in early August which was 1-2 weeks later than in recent years due to the delayed maturity of crops, rather than due to bad weather. Good progress was made between 3-16 August when about 680,000 ha of wheat was harvested. Although harvest was delayed by unsettled weather from 17 August, by 6 September it was almost complete. The more rapid harvest in 2016 compared with 2015 suggests that the risk from wheat bulb fly may be lower than last year and this survey will help determine if this is the case and provide valuable information on the potential risk from the pest for the 2016/17 season.

The overall objective of the project is to establish the annual incidence of wheat bulb fly in the autumn to allow farmers to decide on the need for seed treatment in late-sown crops. Specific objectives are:

1. To measure the incidence of wheat bulb fly each autumn in the infested areas.
2. To forecast the need for seed treatment.

Egg numbers can be estimated by soil sampling and related to threshold levels of 250 eggs/m² (2.5 million eggs/ha) for crops sown in September or October, or 100 eggs/m² (1.0 million eggs/ha) for crops sown from November onwards. At lower infestation levels, economic damage is less likely, although winter cereal crops sown from November onwards or those sown in spring before the end of March can be particularly vulnerable. Larvae attack shoots of wheat, barley and rye from January to April, with yield loss depending on tiller density at the time of attack. Crops still at the single shoot stage in February are most vulnerable and may be completely destroyed (Young, 2000). Yield losses of up to about 4 t/ha have been recorded following severe damage (Young & Ellis, 1996).

The options for control of wheat bulb fly have been reduced by pesticide reviews and withdrawals and are currently limited to a tefluthrin + fludioxinil seed treatment (Austral Plus) and a cypermethrin seed treatment (Signal 300 ES). In 2016 uses of chlorpyrifos-ethyl or products containing chlorpyrifos-ethyl were lost due to a non-dietary risk review of current uses, as a result of the reduction of the toxicological reference values recommended by EFSA. Consequently, chlorpyrifos can no longer be used as an egg hatch spray against wheat bulb fly larvae.

Seed treatment is the most effective option for late-sown crops, for example those at risk following potatoes, sugar beet, onions or red beet. Young (1992) demonstrated that November and December drillings of winter wheat were more vulnerable to wheat bulb fly damage than earlier sowings and are, therefore, more likely to benefit from the use of a preventive insecticidal seed treatment.

3. Materials and methods

A total of 30 fields were sampled in September 2016 in areas prone to wheat bulb fly, with 15 in eastern England and 15 in northern England (Table 1). The survey was stratified to represent some of the main preceding crops (Table 2) leading to a risk of wheat bulb fly damage in each area.

For each field sampled, 32 cores each of 7.2 cm diameter or 20 cores each of 10 cm diameter were taken to cultivation depth. Fields were sampled in a standard W sampling pattern. Wheat bulb fly eggs were extracted following soil washing and flotation in saturated magnesium sulphate. Egg numbers were expressed as number of eggs per m^2.

Table 1. Location of sampling sites, by region and county.

Region	County	Number of fields sampled
Eastern England	Cambridgeshire	8
	Norfolk	5
	Suffolk	2
	Total	15
Northern England	East Yorkshire	12
	North Yorkshire	3
	Total	15

Table 2. Preceding crop for sampled fields.

Preceding crop	Eastern England	Northern England
Fallow	0	1
Oilseed rape	2	0
Onions	3	0
Peas (combining)	0	1
Peas (vining)	1	5
Potatoes	1	8
Red beet	1	0
Soya	1	0
Sugar beet	6	0
Total	15	15

4. Results

In autumn 2016, none of the 30 surveyed fields was considered at very high risk (egg numbers>500/m^2), one field (3%) was considered at high risk, containing egg numbers between 250/m^2 and 500/m^2. Only one field (3%) was above the 250 eggs/m^2 threshold (Figure 1). At 3%, the overall risk in 2016 is the equal lowest recorded since monitoring began in 1984. It is possible that as the winter wheat harvest was ahead of that in 2015 there was less time for saprophytic fungi to develop in cereal ears, which in turn meant less food for adult wheat bulb fly females. As a result they produced less eggs than in a wetter season their fungal food source is more plentiful.

Average egg numbers in the north were similar to those in the east. One field in the east had egg numbers above the 250 eggs/m^2 threshold, whereas none were above this level in the north. Over all sites, the highest risk was after onions (Figure 2), with a mean of 212 eggs/m^2. The next highest risk was after potatoes, with 123 eggs/m^2.

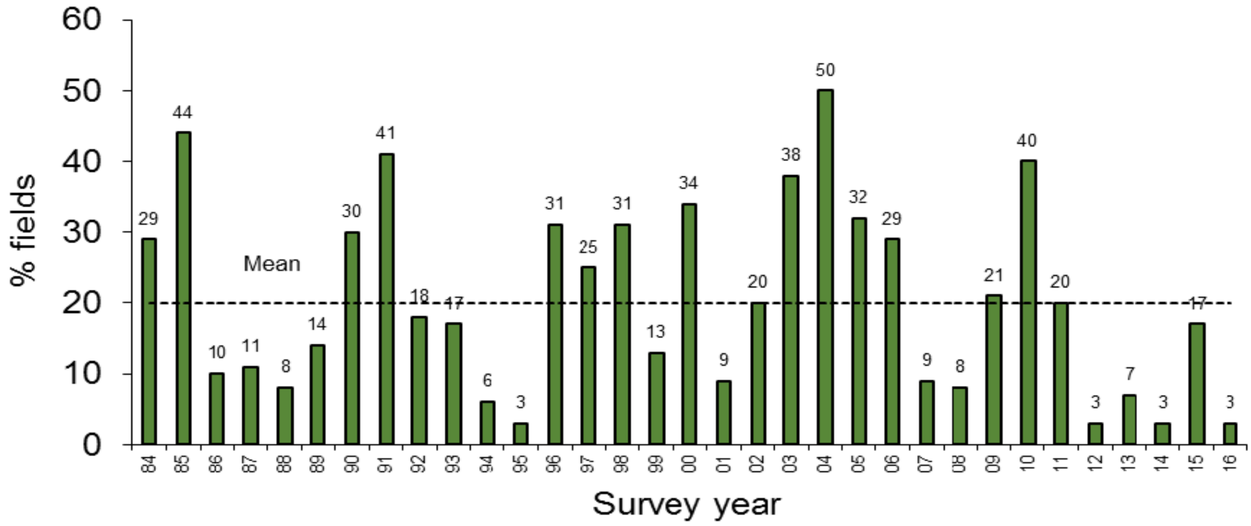

Figure 1. The proportion of fields sampled each year exceeding the threshold of 250 eggs/m^2

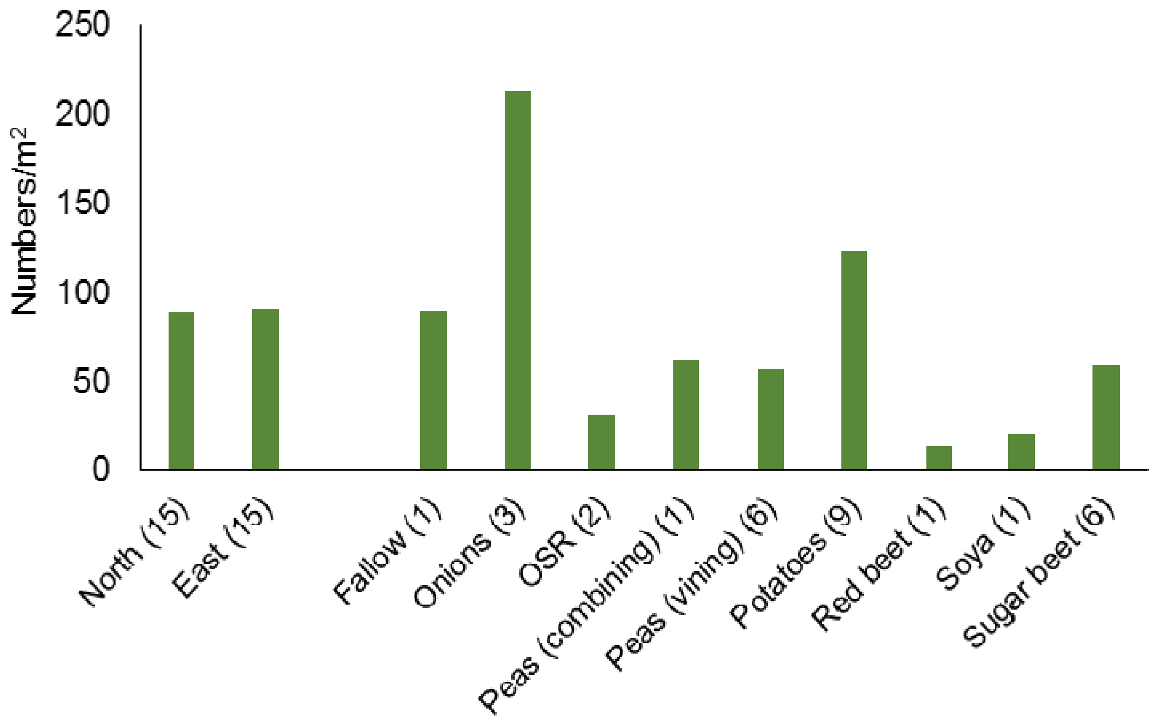

Figure 2. Average egg counts by region and previous crop in autumn 2016 (number of sites in brackets).

4.1. Eastern England

The mean egg number was 90 eggs/m^2 for sites sampled in eastern England. This is higher than in 2014 (46 eggs/m^2) and 2013 (76 eggs/m^2) but much lower than the 179 eggs/m^2 and 309 eggs/m^2 recorded in 2011 and 2010, respectively. Therefore, the potential for wheat bulb fly damage in eastern England is relatively low. However, late-sown crops, which are likely to have few tillers at the time of egg hatch, could still be at risk. The highest egg population of 377 eggs/m^2 was after onions in Suffolk. In total 11 of the 15 sites sampled had egg numbers lower than 100 eggs/m^2. Potatoes had the highest mean number of eggs of all crops sampled (233 eggs/m^2, Table 3), although only one potato field was sampled.

Table 3. Mean eggs/m^2 and preceding crops in eastern England in autumn 2016 (range in brackets).

Preceding crop	Number of fields sampled	Mean number of eggs per m^2
Oilseed rape	2	31
Onions	3	212
Peas (vining)	1	27
Potatoes	1	233
Red beet	1	14
Soya	1	21
Sugar beet	6	58
Mean egg count		90 (14–377)

In eastern England, none of the sampled fields was in the very high risk category and one in the high risk category (Table 4). Overall, four fields (27%) sampled in eastern England contained egg populations in the moderate, high or very high risk categories. This is higher than in 2014 (13%) the same as in 2015 but lower than in 2013 (40%), 2012 (47%), 2010 (80%) and 2009 (67%).

Table 4. Infestation categories and preceding crops in eastern England in autumn 2016.

Preceding crop	Number of fields by rotation and risk category			
	Low (<100 eggs/m^2)	Moderate (100–249 eggs/m^2)	High (250–499 eggs/m^2)	Very high (>500 eggs/m^2)
Oilseed rape	2	0	0	0
Onions	1	1	1	0
Peas (vining)	1	0	0	0
Potatoes	0	1	0	0
Red beet	1	0	0	0
Soya	1	0	0	0
Sugar beet	5	1	0	0
Total	11	3	1	0
% of fields by infestation category	73	20	7	0

4.2. Northern England

The mean egg number was 89 eggs/m² for sites sampled in northern England. This is lower than in four of the last five years (2015:168 eggs/m², 2014: 125 eggs/m², 2013: 129 eggs/m², 2011: 161 eggs/m²). In 2012 egg numbers were slightly lower than in 2016 with 79 eggs/m². The highest egg population of 219 eggs/m² was recorded in East Yorkshire after potatoes.

Table 5. Numbers of eggs/m² and preceding crops in northern England in autumn 2016 (range in brackets).

Preceding crop	Number of fields sampled	Mean number of eggs per m²
Fallow	1	89
Peas (combining)	1	62
Peas (vining)	5	62
Potatoes	8	109
Mean egg count		89 (14–219)

In northern England, none of the sampled 15 fields were in the high risk category, four (27%) were in the moderate category and 11 (73%) were in the low category (Table 6). Overall, four fields (27%) were in risk categories of moderate or above, which is the equal lowest recorded since 2009 (2015: 87%, 2014: 53%, 2013: 40%, 2012: 27%, 2011: 60%, 2010: 60% and 2009: 47%). This represents a relatively low risk to crops sown after November.

Table 6. Infestation categories and preceding crops in northern England in autumn 2016.

Preceding crop	Number of fields by rotation and infestation category			
	Low (0–100 eggs/m²)	Moderate (100–250 eggs/m²)	High (250–500 eggs/m²)	Very high (>500 eggs/m²)
Fallow	1	0	0	0
Peas (combining)	1	0	0	0
Peas (vining)	4	1	0	0
Potatoes	5	3	0	0
Total	11	4	0	0
% of fields by infestation category	73	27	0	

5. Discussion

Egg populations above 250 eggs/m^2 present a risk of economic damage to winter wheat crops drilled in September and October. Egg numbers above 100 eggs/m^2 justify the use of seed treatment on the late-drilled crops of winter wheat or barley sown from November onwards.

5.1. Early sown crops (September/October)

In 2016, 3% of fields (one field out of 30) were over the 250 eggs/m^2 threshold (2.5 million eggs/ha) for crops sown in September or October. The overall risk in 2016 is the equal lowest since monitoring began in 1984. It is possible wheat ears contained a lower level of saprophytic fungi than was the case in 2015. As these fungi provide food for wheat bulb fly adults this might help to explain the low egg numbers in 2016 compared with 2015.

Mean egg numbers in the north were similar to those in the east. In the east one field had egg numbers above the 250 eggs/m^2 threshold, whereas none were above this level in the north. The mean egg count for the east was 90 eggs/m^2 and in the north it was 89 eggs/m^2.

5.2. Late-sown crops (November onwards)

Late-sown (November onwards) or slow developing crops are at greater risk than those that are early sown (September/October) due to slower tiller development. As a result, a lower threshold of 100 eggs/m^2 or 1 million eggs/ha is applicable for these crops. In both the east and north of England, 27% of monitored fields (four fields) were above this level. These fields would benefit from a seed treatment if sown after November.

A summary of control strategies for wheat bulb fly in relation to egg numbers and sowing date is given in Table 7.

Table 7. Wheat bulb fly egg numbers that would justify a seed treatment in crops sown between September and March.

Risk category	Sowing date: Sep–Oct	Sowing date: Nov–Dec	Sowing date: Jan–Mar
Low (<100 eggs/m^2)	Economic damage unlikely; no treatment	Economic damage unlikely; no treatment	Seed treatment
Moderate (100–249 eggs/m^2)	Economic damage unlikely; no treatment	Seed treatment	Seed treatment
High (250–500 eggs/m^2)	No available treatment	Seed treatment	Seed treatment
Very high (>500 eggs/m^2)	No available treatment	Seed treatment	Seed treatment

5.3. Chemical control

Seed treatment (tefluthrin + fludioxinil, Austral Plus or Cypermethrin, Signal 300 ES) is effective on late-sown crops (November onwards) and is the recommended treatment for late autumn or winter sowings of wheat and barley made before the end of egg hatch in areas and rotations at risk from wheat bulb fly. Treated seed should be drilled at a recommended maximum depth of 4 cm in a firm, even seedbed. It is important to note that seed treatments may not be sufficiently persistent to fully protect crops sown in September or October.

If plants are well-tillered by the time that wheat bulb fly larvae hatch between January and March, it is possible that they will be able to tolerate some pest attack.

5.4. Non-chemical control

With the loss of chlorpyrifos egg hatch sprays non-chemical control of wheat bulb fly is likely to become increasingly important, particularly for those crops sown before November for which seed treatments will have limited efficacy.

Parasites and predators can have an impact on numbers of wheat bulb fly eggs and larvae. Ground beetles and their larvae are the main predators of wheat bulb fly eggs and the larvae may be parasitised by small rove beetles (Staphylinidae) particularly *Aleochara bipustulata*. Levels of up to 50% parasitism have been recorded.

The impact of wheat bulb fly can be reduced by sowing early and increasing the seed rate. This is likely to result in a more robust crop which is well tillered before the start of wheat bulb fly egg hatch and so can tolerate and compensate for larval invasion.

Taking account of crop tolerance is fundamental to improving pest risk assessment and achieving a rational approach to pesticide use which is cost effective and minimises the impact on the environment and the potential for the development of resistance (Ellis *et al*., 2009). This approach is the subject of a new AHDB Cereals & Oilseeds funded project entitled 'Crop management guidelines for minimising wheat yield losses from wheat bulb fly' (2140047118). The main aim of this project is to develop crop management guidelines that enable farmers to minimise the risk of wheat yield losses from wheat bulb fly by i) estimating the minimum seed rate, latest sowing date and use of seed treatment that will be required to tolerate wheat bulb fly pressure and ii) estimating the threshold egg or adult wheat bulb fly numbers that justify insecticide treatment for crops with different tolerances to damage. A supplementary aim is to try to improve current monitoring methods for wheat bulb fly so that the risk of attack can be determined as early as possible to help make decisions on the need for insecticide seed treatments. In the absence of chlorpyrifos the project will enable farmers and agronomists to determine the minimum seed rate and latest sowing date combinations, and the need for seed treatment, to minimise the risk of yield losses to wheat bulb fly based on numbers of eggs or adults of the pest, egg viability and crop tolerance. Crop tolerance will be measurable in terms of the number of excess shoots produced by individual crops. In general, the project will significantly improve understanding of the relationship between wheat bulb fly and crop yield. This in turn will help to develop IPM strategies for this pest which minimise reliance on chemical control.

6. References

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Appendix A

Egg populations ranked in descending order for 15 fields sampled in eastern England in autumn 2016

County	Previous crop	Number of eggs (number/m²)	Risk category
Suffolk	Onions	377	High
Suffolk	Onions	233	Moderate
Cambridgeshire	Potatoes	233	Moderate
Norfolk	Sugar beet	137	Moderate
Norfolk	Sugar beet	75	Low
Norfolk	Sugar beet	69	Low
Cambridgeshire	Oilseed rape	41	Low
Cambridgeshire	Sugar beet	34	Low
Cambridgeshire	Onions	27	Low
Cambridgeshire	Vining peas	27	Low
Cambridgeshire	Oilseed rape	21	Low
Norfolk	Sugar beet	21	Low
Cambridgeshire	Soya	21	Low
Cambridgeshire	Red beet	14	Low
Norfolk	Sugar beet	14	Low
Mean		101	

Appendix B

Egg populations ranked in descending order for 15 fields sampled in northern England in autumn 2016

County	Previous crop	Number of eggs (number/m^2)	Risk category
East Yorkshire	Potatoes	219	Moderate
East Yorkshire	Potatoes	151	Moderate
East Yorkshire	Potatoes	110	Moderate
East Yorkshire	Vining peas	103	Moderate
North Yorkshire	Potatoes	96	Low
East Yorkshire	Fallow	89	Low
North Yorkshire	Potatoes	82	Low
East Yorkshire	Potatoes	75	Low
East Yorkshire	Vining peas	75	Low
East Yorkshire	Vining peas	69	Low
North Yorkshire	Potatoes	69	Low
East Yorkshire	Potatoes	69	Low
East Yorkshire	Combining peas	62	Low
East Yorkshire	Vining peas	48	Low
East Yorkshire	Vining peas	14	Low
Mean		89	