# Wheat bulb fly and other fly pests of cereals

SAC

Technical Note

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## Summary

- The risk of pests such as wheat bulb fly, frit fly and leatherjackets can be assessed prior to sowing
- Correct diagnosis of the problem is essential as some insecticides are specific to certain pests

## Introduction

There is a wide range of fly pests of cereal crops, some more common than others, and some that can be considered to be 'curiosities', appearing sporadically depending on the season.

It is the larval (commonly known as grub or maggot) stage of the fly life cycle that causes crop damage, either to the roots (e.g. bibionids, leatherjackets), within shoots (e.g. wheat bulb fly, frit fly) or to the grain (wheat blossom midge).

For several fly pests of cereals, an assessment of the risk of pest damage to the crop can be carried out before planting (e.g. wheat bulb fly, frit fly, leatherjackets), and measures such as cultivation, early sowing, or use of insecticide treatments can be undertaken to reduce the risk of pest damage to the crop.

The main fly pests of cereal crops, particularly from a Scottish perspective, will be discussed and what measures can be undertaken for the management of these pests will be outlined.

## Wheat bulb fly

Wheat bulb fly, *Delia coarctata* (Fallen) is a serious pest of wheat crops in the eastern half of Scotland, causing 'deadheart' symptoms due to feeding by the larva on the central shoot of young plants (Fig. 1). Female flies lay eggs during the summer months (July-September), and bare soil is the preferred oviposition site. Consequently wheat crops sown after potatoes, peas, oilseed rape, field vegetables, fallow, set-aside or any other crop which has areas of bare soil during the summer months are particularly at risk. The eggs begin to hatch in January/February and may continue through into mid-March. Severe damage is only caused to crops that have yet to form multiple tillers. As a general rule, crops sown before mid-October will usually have several tillers by the time wheat bulb fly egg-hatch occurs, so treatment is not always necessary. However, plants that only have single shoots at the time of egg hatch may be completely killed by the grub feeding within the single shoot.

*Fig. 1. 'Deadhearts' in winter wheat due to wheat bulb fly larvae*

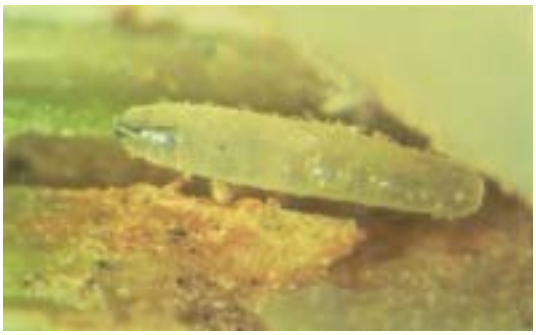

*Fig. 2. Wheat bulb fly larva*

The 'deadheart' symptoms (central shoot turning yellow, Fig. 1) usually become apparent by late February/early March depending on the timing of egg hatch, and the wheat bulb fly grub can usually be found within the shoot (Fig. 2). The grub can reach 12 mm in length when fully grown, and is a creamy-white colour. The grub feeds until May, and may invade several shoots in order to complete its development. The grub exits the plant and pupates in the soil, the adult flies appearing from mid-June onwards. Egg laying in bare soil occurs from late-July through to late-September depending on the season.

Cereal crops at risk from wheat bulb fly are wheat, barley and rye – oats are not attacked. Winter crops sown late and spring-sown crops can be damaged,

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with increased cases of early-sown spring barley crops suffering significant damage in recent years.

The distribution of wheat bulb fly in the UK is restricted to eastern areas, and in Scotland, East Lothian, Fife and Tayside are areas with a long history of wheat bulb fly damage. However, since the early 1990s, several crops of wheat have been severely damaged by wheat bulb fly in the Borders region, and several confirmed reports of wheat bulb fly have been received from the Moray Firth, which suggests that the distribution of the pest may be changing. The restriction of wheat bulb fly to the eastern regions of Scotland has been attributed to the higher rainfall in northern and western regions and where daytime temperatures exceed 9°C for 5½ months in the east.

Treatment thresholds for wheat bulb fly are based on egg counts in soil from fields planned for winter wheat or spring barley. Winter barley is usually planted early enough to be able to withstand any damage by wheat bulb fly. Soil samples should be taken from uncultivated fields likely to be at risk from wheat bulb fly during September. Any earlier, and a period of late egg laying may be missed. Uncultivated fields need to be sampled, as the eggs will still be near the soil surface. Once the fields have been cultivated, the eggs will be buried and an accurate assessment of egg numbers is no longer possible.

Soil samples need to be taken using a standardised method that involves the use of a shovel of the following size; shovel width 11 cm, and height of the sides 3 cm. Soil samples should be taken to a soil depth of 3 cm, and to a distance of 7.5 cm, which can be marked on the shovel. A total of 24 samples should be taken along the longest diagonal of the field.

A wheat bulb fly egg count of 2.5 million eggs/ha (1 million eggs/acre), is the threshold at which damage is likely in the following wheat/spring barley crop. However, lower egg counts may also be of concern depending on the lateness of sowing the winter wheat, seed rate to be used etc.

Early sowing (winter wheat) or late sowing (spring barley) should be the primary method for minimising wheat bulb fly damage if egg counts are high. However, further control measures include drilling insecticide-treated seed, applying an insecticide drench at egg-hatch in January/ February, and applying a systemic insecticide as a 'deadheart' spray when 'deadheart' symptoms are first seen in the crop.

As wheat bulb fly tends to prefer laying eggs in bare soil, fields planned for non-cereal crops can be cultivated during the summer and used as 'traps' to divert egg laying by wheat bulb fly away from fields destined for susceptible crops.

## Frit fly

Frit fly (*Oscinella frit* L.) is a pest of spring oats and winter-sown cereals. Over recent years the prevalence of frit fly has declined, although it is locally common in some areas of Scotland. There are three generations of frit fly a year, and consequently damage can occur to crops at different times of the year and also to different parts of the plant (shoots and grain).

Frit fly grubs overwinter in the shoots of grasses and cereals, so some damage in the form of 'deadhearts' may be seen in winter wheat, barley or oats during the winter months (Fig. 3). This generation of frit fly arises from eggs laid on grasses and volunteer cereals in late summer, and when infested grass or grassy stubble is ploughed in and winter cereals sown, the frit fly grubs (Fig. 4) can leave the buried grass and invade the shoots of the cereals.

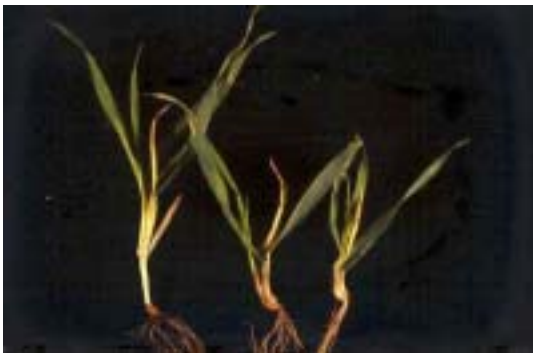

*Fig. 3. 'Deadhearts' in winter barley due to frit fly larvae*

*Fig. 4. Frit fly larva*

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Occasionally early sown winter barley may have eggs laid directly on the young plants.

The frit fly grubs feed throughout the winter, and the next generation of flies appears in May/June and target egg laying onto grasses and young spring cereals such as spring oats and occasionally spring barley. The grub burrows in to the central shoot and may cause 'deadheart' symptoms in spring oats and barley in June/July. Some spring oats may suffer damage to the ears prior to ear emergence, which can result in blind, withered spikelets.

The grubs pupate within the shoot, and the next generation of adult flies emerges in late July, and these target the ears of oats, which are only susceptible for a short period of time after the ears have emerged from the leaf sheath. After flowering is completed, the ears are resistant to any frit fly attack. Frit fly eggs are laid on or beneath the husks of oats, and the grubs burrow into the husk and feed on the oat kernels within. Attacked oat ears are not always evident, and it is only by opening up individual grains that the blackened, thin kernels can be seen. Often a brown frit fly pupa may be present within the grain.

The frit flies arising from this generation lay eggs on grasses and winter cereals that give rise to the overwintering generation.

By far the best option to minimise any damage from frit fly in winter cereals is to plough grass and leave for as long as possible before sowing the winter crop. If the grass has been treated with a herbicide before ploughing then this can shorten the time before drilling cereals; if there is no live grass buried, then the frit fly grubs will soon die from starvation.

An assessment of the risk of frit fly damage to winter cereals can be undertaken by sampling the grass or grassy stubble for frit fly eggs/larvae before ploughing. Depending on frit fly eggs/larvae present, and date of ploughing and drilling, a recommendation can be made on whether an insecticide treatment needs to be applied to the grass to kill off the larvae present.

Frit fly shoot damage to spring cereals is not very common, as most crops will have advanced beyond a stage where significant damage is carried out or is noticeable. However, in crops where sowing was delayed, or the growth of the crop is checked for other reasons, frit fly could cause some problems. There is however a very narrow window of opportunity to control the frit fly eggs/grub before it burrows into the plant, and if damage is seen, it is already too late to apply an insecticide treatment. Crops that have reached the four leaf stage by the time frit flies are actively laying eggs can usually escape any serious damage, as the young side shoots or tillers are preferred by the flies rather than the main shoot.

The next generations' threat to the ears of spring oats in late-July is probably of most concern, and is the most difficult to take any control measures against. However, because the ears are only susceptible to attack during early emergence, an early sown or rapidly developing crop can escape this narrow period of risk from frit fly attack. Insecticidal control is not an option for controlling frit fly attack on the ears of spring oats.

## Leatherjackets

Leatherjackets (Fig. 5) are the common term for larvae of several species of crane fly or 'daddy longlegs', and like frit fly, tend to be a problem in winter and spring cereals sown after grass. The most common species of leatherjacket is *Tipula paludosa* Meig., although there are other species such as *T. oleracea* L. that is an occasional problem in Scotland. A detailed description of leatherjackets is given in another SAC Technical Note (TN 361: Leatherjackets and their control).

*Fig. 5. Leatherjacket – larvae of crane flies*

The common crane fly, *T. paludosa*, has one generation a year, and the fly is usually seen from September onwards. The females tend to lay eggs in closely grazed grassland rather than unmanaged long grass, although grassy stubbles may also be targeted. The eggs hatch within 10 days and the grubs (2 mm in length) feed just below the soil surface on decaying plant material and the roots of plants (Fig. 5). As the grubs develop they may feed on the soil surface and attack leaves and stems above ground.

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The grubs feed throughout the winter and, by the time they finish their feeding cycle in June, can be up to 4 cm in length. Consequently, spring sown crops tend to suffer greater damage than winter sown crops as the grubs are much larger when the spring crops are sown.

Typical damage symptoms are severed or ragged leaves and damage at the stem bases. Cereals may also suffer damage to the seed, resulting in bare patches within the crop. The leatherjacket grubs can usually be found adjacent to damaged plants just below the soil surface.

If grassland is treated with a herbicide, ploughed, and sowing of cereals not undertaken for several weeks, then many of the newly hatched leatherjackets will die through starvation and desiccation. However, simply ploughing in grass without a herbicide treatment allows leatherjackets to survive on buried plant material.

By far the best option to minimise the threat of leatherjackets is to plough grass early, say in July, before egg laying begins. If this is not a viable option, then grass can be sampled for leatherjackets (after egg laying) and the numbers present estimated and the threat to winter cereals and spring cereals determined.

No treatment thresholds have been determined for winter cereals, although it is known that large numbers of leatherjackets may cause damage to early sown cereals. However, later sown cereals tend to escape any significant damage as the cool winter temperatures slow down leatherjacket feeding, although damage may only be delayed until the spring.

Leatherjacket numbers in grassland that exceed 0.6 million/ha are likely to cause damage to subsequent spring cereals.

There are several methods available to estimate the field density of leatherjackets. The standard method adopted by SAC is to use a special soil corer to remove 25 cores of 6.5 cm diameter. These samples are then heat extracted in the laboratory and the escaping leatherjackets collected. This method is best used before grassland has been ploughed.

Sampling for leatherjackets within a cereal crop is impractical using the corer method, as the soil structure is too loose for the cores to be suitable for heat extraction, and a reliable estimate of leatherjacket numbers is not possible. Instead, growers and advisers are encouraged to carry out row scratching of the crop. Several random 30 cm lengths of row should be removed by trowel to below root depth and hand sorted on a large white tray or other suitable surface. Finding one leatherjacket/30 cm of row is equivalent to a leatherjacket population of 0.3 million/ha. As the 0.6 million/ha threshold adopted for leatherjackets in grassland assumes that 50% of the grubs will be killed through ploughing and cultivation, the 0.3 million/ha threshold for treatment is adopted when row scratching in spring cereals.

If leatherjacket numbers after sampling warrant an insecticide treatment, then the best timing for an insecticide treatment is applying it to the grass just before ploughing. If damage only becomes apparent once the spring crop has begun to emerge, then an insecticide treatment may be justified at early crop emergence, particularly if row scratching reveals threshold or above numbers of leatherjackets.

## Orange Wheat Blossom Midge

Orange wheat blossom midges (*Sitodiplosis mosellana* Géhin, Fig. 6) are potentially damaging to wheat crops, although their appearance in Scotland tends to be very localised and often

*Fig. 6. Orange wheat blossom midge*

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*Fig. 7. Grain damaged by orange wheat blossom midge larvae*

hardly noticeable. Confirmation of its occurrence in Scotland tends to be from detailed analysis of grain samples (Fig. 7) from variety trials throughout Scotland, which indicate that damage is usually very low and would have had no effect on yield loss. Typical symptoms of damage are shrivelled grain, often with a shallow depression where the larva has been lying. The level of grain damage seen in Scotland is unlikely to have led to soil populations of 6 million larvae/ha, which is the minimum necessary to pose a risk to wheat crops. The levels of midge damage to Scottish crops has never been on the scale of that seen in recent years in England, and it is very unlikely that a similar build-up of midge populations in Scotland would have passed unnoticed.

The appearance of the midge is dependent on air temperatures during May and June where mean daily air temperatures exceed 15°C. In Scotland these sort of temperatures are often not reached on a steady basis. Crops of winter wheat are only at risk from midge attack between early ear emergence and the beginning of flowering (GS55–59) and if mean air temperatures don't reach 15°C during this growth stage of the crop, then the crop will be safe from midge attack. Midge populations are unlikely to be as high as those seen in England and the risk from serious midge damage is consequently much lower.

After feeding on the grain, the orange grubs fall to the ground in the summer and spend the winter as cocoons in the soil. Temperatures above 13°C in May wake up the larvae in the cocoons and they move up toward the soil surface, and if the top 10 mm of soil is damp, they form pupae. Emergence of adult midges from the pupae is triggered by mean daily air temperatures exceeding 15°C, and emergence can be spread over several weeks. Once the midges have emerged, they mate immediately and the females begin to search for crops in which to lay their eggs. Midges can be carried in the wind, or fly in a light wind for a few kilometres, and are attracted to the smell of a wheat crop. Once finding a crop, the midges will not begin to lay eggs on the ear until early evening when temperatures exceed 15°C. At temperatures below this, the midges will sit on the lower leaves, often for several days waiting for the temperature to rise. After laying, the eggs can hatch after 5–7 days, and once the larvae have begun to attack the grain they cannot be controlled. Consequently there is a very narrow window of 5 days after egg-laying during which an insecticide spray can be applied to kill the eggs before hatching.

To determine whether wheat crops are at risk from wheat blossom midge, growers should keep an eye on crop growth stage and the weather. Midges can only attack crops between early ear emergence and the onset of flowering (GS55–59), and if mean daily air temperatures exceed 15°C during dry weather. If these conditions coincide, then growers should look for midges in the crop. This is best carried out shortly before dusk on still evenings when the midges will be moving up to the ears from the lower leaves. Spraying is only necessary if one midge is found per three ears in a feed wheat crop, and one midge every six ears in a seed or milling crop. The midges are an orange colour and will usually be found sitting on the ears.

If these thresholds have been exceeded, insecticide treatments need to be applied within five days of the midges exceeding threshold levels.

## Bibionids

There are several species of flies commonly referred to as bibionid flies. The most common in Scotland are the St. Mark's fly (*Bibio marci* (L.)) and the fever fly (*Dilophus febrilis* (L.)). Bibionid flies are stout, black and often hairy flies, and numbers can be very high particularly in early spring and persist throughout the summer.

Adult St. Marks flies usually appear toward the end of April and often form large swarms which may be a nuisance to agricultural workers. They may also congregate around houses and cause concern. Fever flies appear in early spring and can often still be seen in October.

Adult bibionid flies prefer to lay eggs in grassland or soil high in organic matter such as soils manured the previous season. They also lay eggs directly into manure heaps, which may then be applied onto the

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soil. Rotting vegetation such as straw stubble also attracts adult flies for egg laying.

Eggs will be laid from May through to August (or even later in the case of fever flies) and over 30 eggs may be laid at a time which leads to the clumps of bibionid larvae usually found in the soil.

Adult flies pollinate fruit and other crops and feed on nectar from flowers and are considered to be the second most important pollinators after bees.

Egg hatch does not occur until the late summer, and initially the larvae (Fig. 8) will feed on organic matter in the soil. Damage is most often noticed in grassland and crops under some form of stress such as low fertility, shallow roots or excessive application of manure/slurry.

*Fig. 8. A bibionid larva*

Damage to grassland is usually noticed in November/December or early in the new year when patches of yellow plants are noticed. The larvae sever the roots of grasses, causing reduced uptake of nutrients and water and eventual death of the plant. Damage may often be confused with that of leatherjackets, and insecticide treatments to kill leatherjackets will also have an effect against bibionids.

Damage to cereals is usually noticed by gaps in the drills, and pale plants in patches throughout the field. Seed may be hollowed by larvae or more commonly the roots trimmed so that nutrient uptake is disrupted.

Deep ploughing, harrowing and rolling can reduce larval numbers in crops after grass.

Insecticides used to control leatherjackets will have some effect on bibionid larvae, but timing may be important. In November/December the larvae are small and near the soil surface but from February onwards the larvae may be deeper in the soil and more difficult to kill with an insecticide.

Growers should check soils in November for the presence of bibionids (usually found in clumps of 15 or more) and seek advice on whether control is necessary.

## Other fly pests

Occasionally, other fly pests may be seen in Scottish crops, but are usually below levels causing significant damage, and are of minor importance.

Yellow cereal fly (*Opomyza florum* (F.)) is often confused with wheat bulb fly, as the larvae are present at the same time – from January through to May. The symptoms of damage are similar; 'deadhearts' due to death of the central shoot. However, yellow cereal flies tend to target early sown cereal crops, laying eggs near plants in the autumn.

Several cases of gout fly (*Chlorops pumilionis* (Bjerk.)) were found in Scotland during the 2001/2002 season. Plants attacked by gout fly larvae during early growth become stunted and have swollen or 'gouty' stems. The larvae of the gout fly can usually be found within the swollen stems. Early sown cereals tend to be more at risk as the flies lay eggs directly onto the young plants.

## Management of fly pests of cereals

***Monitoring***

Wheat bulb fly, frit fly and leatherjacket populations can be gauged by monitoring the field before planting. Wheat bulb fly eggs can be sampled in September prior to soil cultivation. Leatherjacket and frit fly grubs can be sampled from grass before ploughing and the risk to following crops determined.

SAC monitor levels of frit fly adults in water traps to gauge trends in populations, but this does not necessarily translate into specific risks for individual fields.

Each autumn SAC carry out a survey of wheat bulb fly egg populations from Tayside down to the Borders to gauge the general level of risk.

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SAC carry out an annual survey of leatherjacket populations in grassland, but this is mainly restricted to the south west area of the country.

Effective in crop monitoring is only worthwhile for leatherjackets at spring barley emergence by row scratching, and in looking for signs of wheat blossom midge activity on warm, still summer evenings.

***Cultural management***

There are several effective cultural techniques that can be adopted for reducing the risk of damage to crops by fly pests.

In the case of wheat bulb fly, having fallow areas in fields during the summer will attract flies for egg laying, and if these fields are not planned for cereals, then they can have a significant impact in diverting egg laying away from fields planned for cereals. Because wheat bulb fly prefer to lay eggs in bare soil, crops at risk tend to be those after crops where harvest is early such as potatoes, oilseed rape, field vegetables, or where the fields have been fallow. Early sowing of wheat can allow early crop establishment, which can circumvent even high egg populations. Later sowing increases the risk of wheat bulb fly damage.

As frit fly and leatherjackets are mainly a problem after grass, delaying sowing for several weeks after effective grass cultivation can reduce the risk of damage considerably. This is particularly important if growing spring barley, where leatherjackets can be a significant problem if allowed to prosper over the winter months in grass, and the grass isn't effectively destroyed several weeks before sowing the barley.

The risk from bibionids can be reduced by avoiding the application of slurry to fields during the summer months, and by effective incorporation of crop stubble to avoid it rotting on the soil surface and being attractive to actively egg laying bibionid flies.

Wheat blossom midge tends to more of a problem in second and third wheats, so avoiding serial wheat growing will reduce the risk of wheat blossom midge significantly.

***Insecticides***

Insecticide use for the control of cereal fly pests is only recommended if growers know they have a problem. i.e. a significant risk based on wheat bulb fly egg counts, frit fly larval counts, leatherjacket counts etc. Insurance treatments should not be applied, as they are often a waste of money and environmentally unacceptable.

## Wheat bulb fly

In the case of wheat bulb fly, the best option if egg counts are high, and the crop is going to be sown late (from mid-October onwards) is to treat the seed with an insecticide seed treatment. At the time of preparing this Technical Note, the only insecticide seed treatment available that will protect wheat seed from wheat bulb fly attack is tefluthrin (Evict). However, it should be borne in mind that there may be 3 months or more between sowing the treated seed and wheat bulb fly egg hatch, and as egg hatch can stretch from late January through to mid-March, the seed treatment may not protect against the later hatching larvae.

The next best option is to apply an insecticide as a soil drench at the time of egg hatch. Chlorpyrifos (e.g. Dursban, Spannit) is the only insecticide approved for this timing, and its effectiveness depends on growers being able to get onto the land at the right time, as the soil conditions and weather may delay application which could affect the level of control. Other factors to consider are leaching and breakdown of the insecticide after heavy rainfall in January/February, and the extended period of egg hatch.

The last resort option is the use of dimethoate as a systemic 'deadheart' insecticide treatment when deadheart symptoms begin to appear in the crop. The fact that deadheart symptoms are being seen indicates that a fair amount of plant invasion by wheat bulb fly larvae is already underway, and plants showing symptoms are already a lost cause.

## Frit fly and leatherjackets

If populations of frit fly larvae and leatherjackets in grass indicate a risk to following cereal crops, and the turnaround between desiccating grass, ploughing and sowing the crop is tight, then one option is to treat the grass with chlorpyrifos (e.g. Dursban, Spannit) and plough in the treated grass. This will kill off many of the larvae and give a reasonable degree of protection to the following crop.

Applying chlorpyrifos at early crop emergence is another option, but is less effective as frit fly larvae for example may already have entered the plant and will be protected from the insecticide.

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## Wheat blossom midge

If adult wheat blossom midge numbers exceed the thresholds for treatment outlined above, then a treatment with chlorpyrifos (e.g. Dursban, Spannit) specifically targeted at the adult midges can be applied. However, any aphicides applied at around the same timing (excluding pirimicarb) should have had an effect on midge numbers to some extent.

## Bibionids

There are no approved insecticide treatments for bibionid larvae, however, use of insecticides for leatherjacket and frit fly control will have an effect on bibionid larvae, particularly if applied during the late-summer or autumn.

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