HGCA

Pest management in cereals and oilseed rape – a guide

Autumn 2003

The impact of pests on yield and quality can be more variable than that of many diseases. However, they do pose a serious threat to UK crops and can reduce yield by 10% or more, sometimes much more.

With increasing concerns about the environment, there is a need to balance pest control against encouraging other insects which can actually benefit the crop.

Integrated strategies seek to use cultural control options, encourage natural enemies and only use crop protection methods when they are fully justified – usually by the use of thresholds.

Developing such strategies depends on a sound understanding of pests, their life cycles and their natural enemies. This guide brings together the latest knowledge from research funded by Defra and HGCA.

Jon Oakley, a leading entomologist, has gathered here information that will be invaluable to growers who seek to minimise pest damage, maximise the marketability of their crops and enhance the environment on their farms.

Professor Graham Jellis
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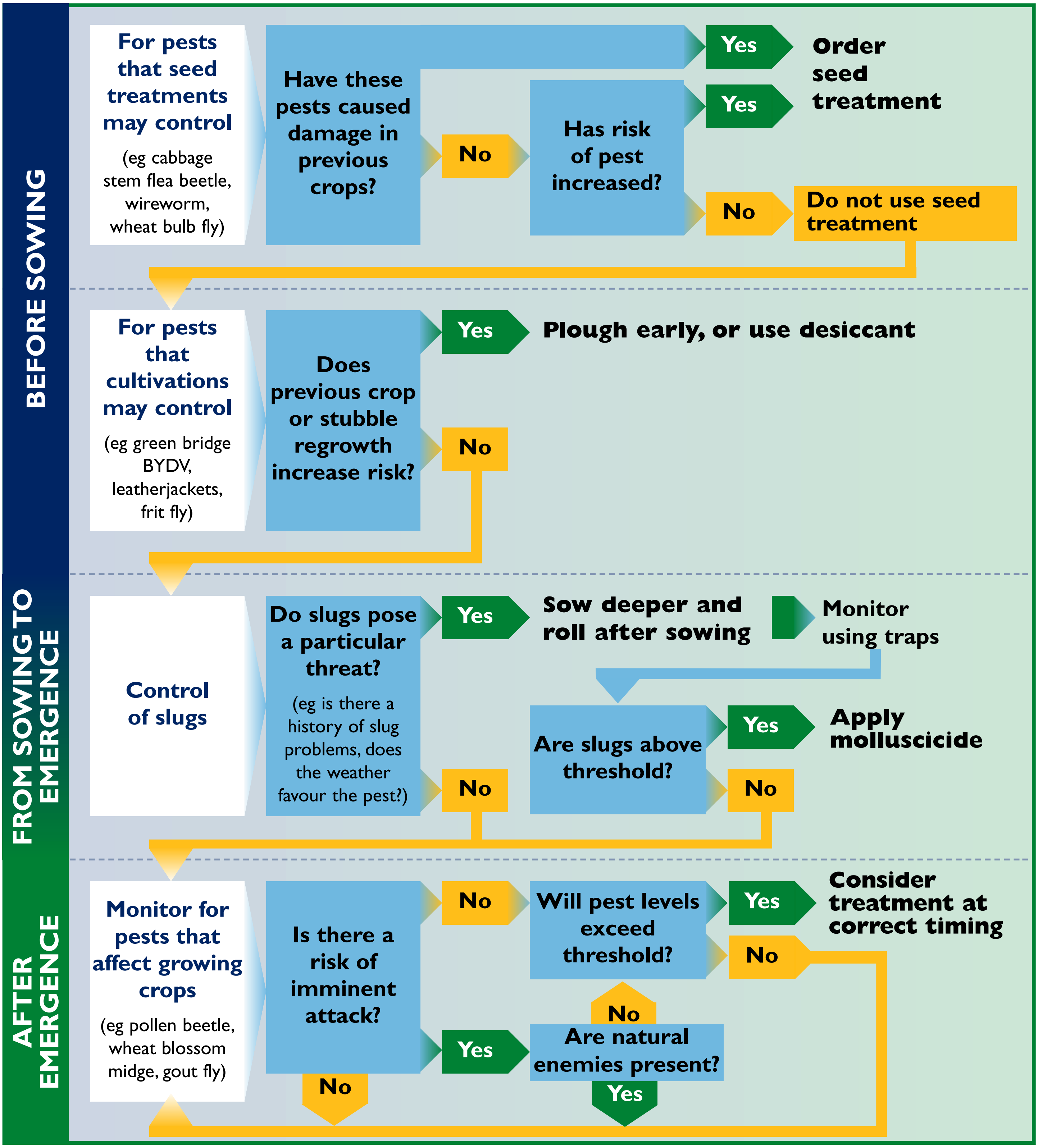
Front cover: Gout fly and parasitoids on wild flowers in a field margin.

Effective pest control

- Assess the risk of infestations.
- Minimise pest risk by cultural means.
- Maximise the effects of natural enemies.
- Only use treatments if economically justified.

General principles of pest management



BYDV

Two different aphid species transmit barley yellow dwarf luteovirus (BYDV) to cereals and grasses in the UK. Very low populations, which may go unnoticed, can cause economic damage.

In autumn most aphids probably come from grasses, especially perennial ryegrass. Virus may also come from other cereal crops and volunteers.

Grain aphid

Sitobion avenae

The aphids may be green, red or brown with black legs.

Transmits: The MAV and PAV strains of BYDV.

Economic importance

The grain aphid is the main BYDV vector in eastern, mid and northern Britain. Losses can be up to 2.5 t/ha.

Risk factors

Winter crops: In mild winters significant spread may occur in any crops exposed to migrations of the winged aphids. These can continue into November and infect later sown crops.

Spring crops: After mild winters BYDV may be transmitted to late-sown crops by winged aphids.

Life cycle

The grain aphid is mainly asexual feeding on cereals and grasses all year round. The aphid is more frost-resistant than the bird cherry-oat aphid with a LT_{50} (lethal temperature for 50% of the aphids) of -8°C. Grain aphids survive on crops through most winters. Numbers increase during mild spells when further BYDV spread may occur.

Bird cherry-oat aphid

Rhopalosiphum padi

The aphids are green to dusky brown with rust red patches at the rear.

Transmits: The PAV and RPV strains of BYDV.

Economic importance

The bird cherry-oat aphid is the main vector of BYDV in south-west England and in warm autumns elsewhere.

Risk factors

Winter crops: Crops sown early, particularly in a warm autumn, are most susceptible to bird cherry-oat attack. These conditions allow aphids to breed rapidly before frosts kill them.

Spring crops: After mild winters BYDV may be transmitted to late-sown crops by winged aphids.

Life cycles

The asexual strain
– overwinters on cereals and grasses.
Aphids are frost-susceptible, the LT_{50} being -0.5°C. In colder winters survival of this strain is restricted to milder coastal districts.

The sexual strain
– overwinters as eggs on bird cherry trees.
Most wild bird cherry trees are found in northern Britain although they occur across the UK.

Eggs of bird cherry-oat aphid are very frost-resistant. Bird cherry trees are not infected by BYDV, so spring migrants are initially virus-free. Aphids of the sexual strain do not transmit BYDV within winter cereal crops.

Both species

Natural enemies

Ground beetles and spiders may attack aphids in the autumn and winter and parasitoids can be active in mild weather. Minimum tillage leaves more predators, but increases the risk of 'green bridge' transfer.

Grass banks and grassed field margins may assist predator survival, but can also harbour infective aphids. Grassed areas should be considered in large arable fields of 20 ha or more.

'Green bridge' transmission

Warm, moist soil conditions facilitate aphid movement through soil. 'Green bridge' transmission is most likely in south-west England, on early-sown crops and in mild, damp autumns.

Aphids can transfer directly from grass or ploughed-down grass or weedy stubbles to new cereal crops. The aphids can feed on new crop roots, and transmit virus directly without appearing above ground level to provide a control opportunity. Any cereal aphid species present may transmit virus – often the RPV strain of BYDV.

Cultural control

1. Clean stubble before preparing seedbed.
2. Leave at least five weeks between ploughing and sowing the new crop.
3. Consider applying a desiccant herbicide if cultivation to sowing interval is less than five weeks.
4. Delay sowing by a week to reduce BYDV spread by up to half.
5. Choose a moderately resistant spring barley variety (see HGCA Recommended Lists) if growing crops after mild winters or in milder districts.

Chemical control

Applying a seed treatment incorporating imidacloprid (Secur) can provide about six weeks' protection, less at very low seed rates. It may not replace the need to spray.

In mild seasons the threat of aphid infestation may continue through the winter.

A pyrethroid spray will kill most wingless aphids.

Chemical control is ineffective on spring-sown crops.

Action thresholds

No satisfactory thresholds for treatment exist.

Spray timing

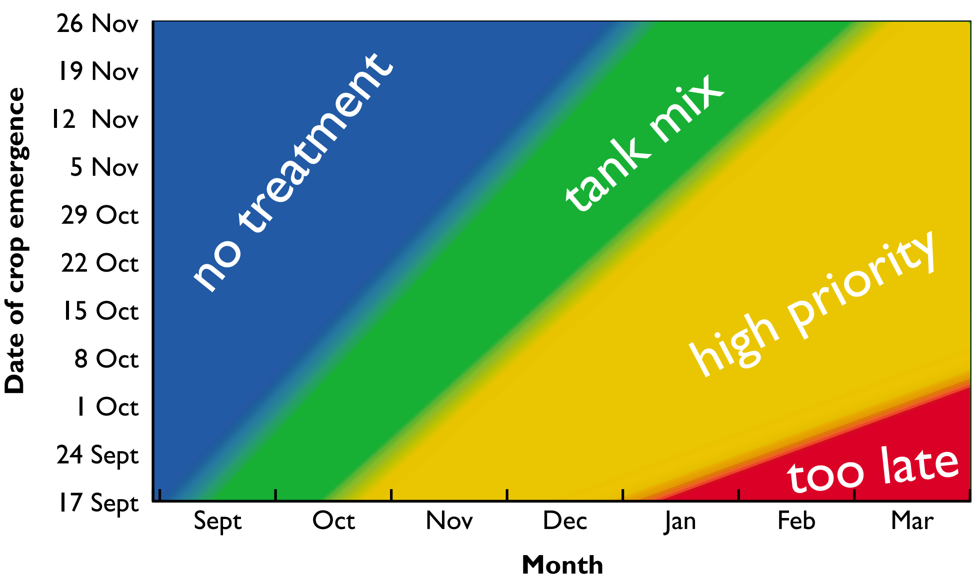
BYDV starts to spread within the crop when the second wingless aphid generation emerges. Spread, initially slow, accelerates as the third wingless aphid generation appears. Aphid breeding is governed by temperature, so a 'T sum' system of accumulated day degrees above 3°C can be used to predict best spray timings. Temperature accumulation should be started from:

- six weeks after sowing for imidacloprid-treated crops
- date of emergence for other crops
- one week after application for pyrethroid-treated crops.

1. Calculate '**T sum**' by subtracting 3°C from the daily mean temperature and adding the result to the running total.
2. If 'T sum' is 170 (second generation could be starting)
   – consider a tank-mix insecticide if treating the crop for another purpose.
3. If 'T sum' is 340 (significant spread imminent)
   – apply a spray treatment as a priority.

A crop should suffer little yield loss from fresh BYDV infection after GS 31 or after a prolonged cold period. A month with mean daily temperatures below 5°C will severely reduce grain aphid survival.

An example of the effect of date of crop emergence on need to spray in a mild winter



Early emerged crops are most at risk of BYDV infection. Decisions on whether to treat crops emerging in September must be made by the start of October. The treatment window is wider for later-emerging crops.

Use 'T-sum' (see above) for specific locality.

The grey field slug is mottled grey and of medium size.

Grey field slug

Deroceras reticulatum

Many slug species are found in arable fields. Only the grey field slug is of economic importance on cereals and oilseeds.

Economic importance

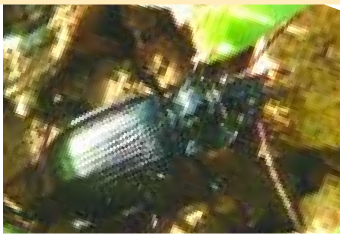
Slugs are most damaging to seeds and seedlings. Cereals are vulnerable up to the fourth leaf stage (GS 14); oilseed rape to the four true-leaf stage (GS 1.4). After these stages slug grazing does not generally threaten plant survival.

Risk factors

All cereal and oilseed crops, particularly if grown on heavier, wetter soils and sown in loose, cloddy seedbeds, are vulnerable. Such conditions allow access to seeds and germinating seedlings and also favour slug survival.

Natural enemies

Several predators eat slugs. Ground beetles are probably the most common in arable fields.



Cultural control

Cultivation in dry conditions leads to physical damage and desiccation.

Cereal seed should be sown at least 12 mm deep. For all combinable crops soil consolidation prevents access to seed as well as encouraging seed-to-soil contact, and rapid germination. A Cambridge roller is suitable.

Chemical control

Slug pellets are effective at the soil surface for 4–7 days, but only kill actively feeding slugs. In mild, damp weather pellets only kill a proportion of sexually active mature slugs. Juveniles often escape as they remain in the soil. Pellets have limited impact. Damage may resume within a month or, if conditions improve, weeks of treatment.

Action thresholds

Action thresholds for cereals are based on slug numbers caught in refuge traps – before or after treatment. These can be made from plant pot saucers or tiles, baited with layers mash, or proprietary mats can be purchased. Catches reflect numbers of slugs active on the surface, not in the soil. Traps only give useful information when mild damp night conditions encourage activity.

A catch of four or more slugs a trap generally justifies treatment, provided conditions remain favourable.

The threshold applies to cereal crops. Slightly lower numbers are probably worth controlling in oilseed rape.

Trapping, and treatment if the threshold is exceeded, is generally advised:

- before sowing if the field has a history of slug damage
- before sowing if wet weather delays sowing in a prepared seedbed
- following sowing if seedbed tilth is poor and further consolidation is not possible
- the crop is slow to emerge or to grow to GS 1.4 and when damage is visible.

Life cycle

There are two generations each year.

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	Distinct spring (and autumn) breeding peaks lead to two overlapping generations at any time.							Distinct autumn (and spring) breeding peaks lead to two overlapping generations at any time.			

The grey field slug breeds year round exploiting any mild, damp periods. Mature adult slugs each lays up to 500 eggs. Typically many eggs and young slugs die from desiccation which keeps populations stable. If weather conditions are particularly favourable and mortality low, populations may increase to very high levels.

Slugs feed opportunistically on a wide range of plant material changing from male to female as they mature. They are inactive in unsuitable conditions and resume feeding in mild, damp, still weather.

Upper surface black with yellow beneath, three black stripes on thorax.

Gout Fly

Chlorops pumilionis

Larvae feeding in stems cause a 'gouted' appearance – swollen main stem and primary tillers with leaves puckered and torn above. In winter crops, damage is first seen in December, but mainly in January/February. Infested spring-sown crops show damage in June and July which prevents ear emergence from the flag leaf.

Damage tends to be highest in sheltered fields near woodland.

Economic importance

The pest is present across the UK, but only causes economic damage from the south coast to the midlands in wheat, barley and triticale. Incidence appears to be moving north. In 2002, high levels of damage were seen in early-sown crops as far north as Staffordshire and Lincolnshire.

Winter damage kills affected tillers and any still dependent on the mother plant. Unaffected tillers, with a developed crown root system can survive and compensate for damage at lower levels of incidence. Where half the crop or more is damaged, yield losses range from 0.25 tonnes/ha to total crop failure.

Shoots damaged by spring generations lose 30% of grain yield on average. Late-sown crops suffer losses up to half of their potential yield.

Risk factors

Crops emerged by the end of September are at greatest risk from the autumn generation.

Late-sown winter and spring crops are at greatest risk from the spring generation. Egg-laying commences in mid-May in the south of England, late May in the midlands. Crops at, or beyond, GS 37 by this time suffer little damage.

Oats are immune, but gout fly can attack couch grass.

Natural enemies

Larvae of the parasitoid wasps, *Stenomalus micans* and *Coelineus niger*, feed inside the gout fly larvae. They can kill 80% or more of gout fly larvae. Adult wasps are active slightly later than gout flies and could be vulnerable to late insecticide applications.

Stenomalus micans

Cultural control

- Sow winter wheat and barley in sheltered fields near woodland after late September.
- Sow spring crops as early as practicable in areas where damage is prevalent.

Chemical control

Chlorpyrifos and pyrethroid insecticides, used to control frit fly and BYDV vectors respectively, will give useful control of the autumn generation where sprays are applied before eggs hatch. In 2002, treatments after early October were ineffective.

Action thresholds

Limited evidence suggests that treatment is economic in winter crops if eggs are found on more than half of the plants at GS 12.

No threshold exists for spring-sown crops.

Larvae feed by secreting enzymes to break down surrounding tissues. This causes no obvious damage to shoots. As the stem extends this break develops into a line of damage.

Life cycle

There are two generations each year.

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Larvae feed.	Larvae pupate in stem.	Pupation		Adult flies hatch. Eggs laid on uppermost unfurled leaf and hatch in 7–10 days.	Larvae crawl into leaf sheath and feed on leaf sheath beneath ear.	Larvae pupate in leaf sheath.	Adult flies hatch before harvest.	Adults shelter in wooded areas and hedgerows. Eggs laid on upperside of first unfurled leaf.		Larvae feed.	

Wheat bulb fly

Delia coarctata

Wheat bulb fly larvae attack shoots of wheat, barley and rye from January to April. They bore into plants, feed at the shoot base and eat through the central leaf which dies, causing the classic deadheart symptom. Larvae lack legs and are white to pale yellow with a blunt tail end.

Economic importance

Yield loss depends on tiller density at the time of attack. Crops still at the single shoot stage in February are most vulnerable and may be totally destroyed. Well-tillered crops generally withstand up to 100 larvae/m² without economic impact on yield.

Risk factors

All cereals, except oats, can be attacked. Adults fly up to half a mile from previously-attacked fields to lay eggs. They lay eggs on stubbles after cultivation and prefer freshly-turned soil. Under hot, dry conditions they lay eggs between row crops, especially if the foliage is wilting.

Eggs may be laid on:

- bare soil following fallows, set-aside, or early harvested crops (eg vining peas) if cultivated between mid-July and mid-August
- row crops, eg sugar beet, potatoes and onions but not brassicas.

Frequency of attack depends on the population of vulnerable first wheats on the farm:

- more than 25% – regularly
- 10–25% – occasionally
- less than 10% – rarely.

Natural enemies

The main egg predators are ground beetles and their larvae.

Small rove beetles, particularly *Aleochara bipustulata* may parasitise the pupae, and kill up to 50% of them.

Cultural control

Avoid cultivating fields destined for wheat in late July and early August. This reduces numbers of eggs laid, especially if fields for oilseed rape, and other non-host crops, are worked at this time.

Early sowing reduces the impact of wheat bulb fly, but increases survival of larvae and numbers on the farm the next year.

Chemical control

Tefluthrin seed treatments are effective with later sowings, but may not fully protect earlier-sown crops. Drill treated seed no deeper than 40 mm.

Chlorpyrifos egg hatch sprays are applied between the start of egg hatch in January and its peak in February or March. Egg hatch is monitored each year to provide information on timing and the need to add, or switch to, dimethoate for later sprays.

Dimethoate is applied when deadhearts first appear in March. It should be applied before larvae move off to attack other shoots in late March.

Action thresholds

Egg numbers can be estimated from soil samples. Each year ADAS forecasts (available through Dow*) the proportion of fields likely to exceed threshold levels:

- above 5 million eggs/ha – damage inevitable, extra measures needed
- 2.5–5 million eggs/ha (sowing Sept–Oct) – damage likely
- less than 1.25 million eggs/ha (sowing Nov–Mar). Late sown crops may suffer damage.

Plant samples may be examined to determine numbers of larvae present when deadhearts are first found. Stripping off the outer leaf sheath can reveal a brown stain where larvae are feeding. A small entry hole in the leaf sheaf confirms that a larva has entered. The thresholds assume plant populations of at least 200 plants/m²:

- 10% tillers attacked @ GS 20
- 15% tillers attacked @ GS 21
- 20% tillers attacked @ GS 22 onwards.

Life cycle

Jan – Mar	Larvae hatch and invade shoots of wheat, rye and barley.
Mar – Apr	Larvae attack 3–5 further shoots.
May	Larvae pupate at base of plants.
June – July	Adults feed on saprophytic fungi on host plants.
Aug	Eggs laid on bare soil and between row crops.
Sept – Dec	Overwinters as eggs.

** Dow AgroSciences Technical Hotline – 0800 689 8899*

Yellow cereal fly

Opomyza florum

Yellow cereal fly, like wheat bulb fly, causes 'deadheart' as larvae enter through the top of the shoot. The yellow cereal fly larva does not leave an entry hole; wheat bulb fly larva does. The larva, yellow and with a pointed end, looks similar to frit fly, but occurs later in the winter.

Economic importance

Each larva damages only a single shoot so economic impact is generally low. Most crops can withstand a considerable number of larvae by producing compensating tillers.

Risk factors

Crops at low plant populations and early-sown crops in sheltered fields close to woodland are at greatest risk.

Natural enemies

The eggs and pupae are the most vulnerable stages to predation by ground beetles.

Cultural control

- Establish at least 200 plants/m^2 in vulnerable situations.

Chemical control

Pyrethroid sprays applied to control BYDV vectors also control yellow cereal fly. No treatments are recommended once larvae have entered plants.

Action thresholds

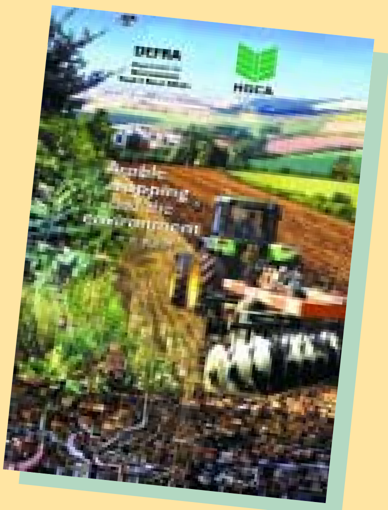
No action thresholds have been established.

Life cycle

Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec

- Jan–Feb: Eggs overwinter.
- Feb–Mar: Eggs hatch.
- Feb–May: Larvae enter and feed on wheat shoots.
- May: Larvae leave the shoots to pupate in soil.
- June: Adult flies hatch.
- June–Aug: Adults spend the summer in woodland.
- Sept–Oct: Flies move to early-sown wheat crops in late September.
- Oct: Eggs are laid at the base of plants.
- Nov–Dec: Eggs overwinter.

Arable and cropping and the environment *– a guide* assesses how any one management decision affects all other decisions in an integrated cropping system.



Wireworms

Agriotes lineatus
Agriotes obscurus

Wireworms are the larvae of click beetles. Yellow larvae with distinct legs at the front and two dark spots at the tail, bite into stems at the soil surface causing a hole with tattered edges. By the time this is evident, wireworms have usually moved along rows to attack further shoots.

Economic importance

Wireworms have become a more serious pest since the withdrawal of organochlorine insecticides and the increase of winter cropping. They can now affect all winter cereal or winter cereal/ley rotations. Heavy infestations can cause yield loss of up to 0.6 t/ha in cereals.

Peas, linseed and flax are more tolerant of damage than other crops.

Risk factors

Crops at highest risk are sown within two years of ploughing out permanent pasture. However, any rotation with predominant winter cropping, particularly with grass weeds, is at risk.

Natural enemies

The main natural enemies are fungi and parasitic wasps.

Cultural control

- Consolidate seedbeds to restrict movement.
- Control grass weeds.
- Consider including a spring crop in the rotation.

Chemical control

Seed treatment with tefluthrin or imidacloprid controls moderate attacks.

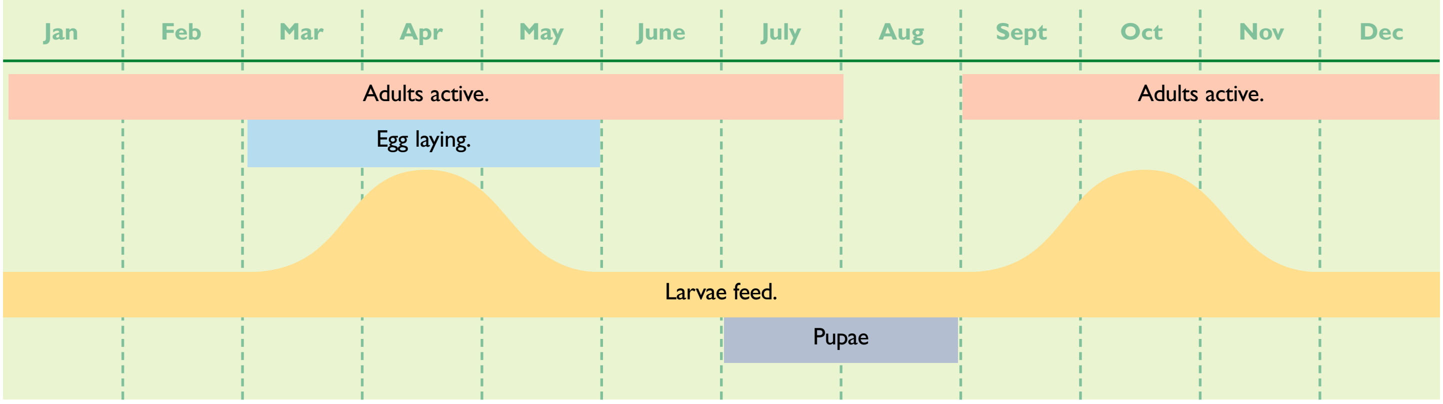
Action thresholds

Populations can be very patchy so estimating numbers is difficult. Examining soil cores in the field for larger wireworms or in the laboratory for smaller ones is costly and rarely justified.

- Use a seed treatment if wireworms exceed the threshold of 750,000/ha. Some residual damage is likely if numbers exceed 1.25 M/ha.

Life cycle

Wireworms have a 4-5 year life cycle.



Adult click beetles cause no economic damage. They live for about a year and lay eggs in grass fields. Larvae then feed for five years before pupating in the spring. Numbers increase over the years; highest populations occur in old permanent pastures. Wireworms feed in ploughed-down turf for about six months before moving to the surface to damage the next two crops.

Leatherjackets

Tipula paludosa
Tipula oleracea

Leatherjackets (grey, legless larvae of cranefly, or daddy longlegs) feed below the soil surface making stems at the surface appear ragged. Stems break and keel over. Wireworms and other minor pests cause similar effects.

Economic importance

Yield losses can range up to total crop loss at the highest infestation levels. Loss depends mainly on September rainfall.

Risk factors

Attacks on all cereals and oilseeds frequently occur following grass, where populations build up. Adults do not fly far and infestations take some years to develop. Larvae continue feeding in ploughed down turf. When it rots they move to feed on the new crop. This leads to damage suddenly appearing some weeks after crops emerge.

Dry September weather can reduce numbers considerably as eggs and young leatherjackets are vulnerable to desiccation.

Natural enemies

A range of viral, bacterial and protozoan diseases attack leatherjackets. Rooks are attracted to patches of leatherjacket damage and may indicate infestations. Predatory soil insects, eg ground beetles, eat eggs and young larvae.

Cultural control

- Plough early before most eggs are laid to reduce carry-over.

Chemical control

Chlorpyrifos is the only approved chemical.

Action thresholds

- Assess leatherjacket numbers, before ploughing, by examining soil samples or flooding plastic pipes, driven into the ground, filled with brine. Proprietary brine-based testing kits are available.
- Assess leatherjacket numbers, in established crops if damage is seen, by scratching soil either side of crop rows.
- Treat with chlorpyrifos if:
  - over 50 leatherjackets/m² for spring cereals (5 in 12 pipes)
  - 5 leatherjackets/m of row in spring cereals.

  Lower levels may cause significant damage in spring oilseed rape and linseed.

A plastic pipe driven in the ground is filled with brine.

Life cycle

Two species cause economic damage.

Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec

Tipula paludosa

Larvae (Jan–Apr)

Larvae pupate near soil surface. (May)

Pupae (June–July)

Adults emerge. (Aug)

Flying adults lay eggs. (Aug–Sept)

Eggs hatch. (Sept)

Larvae (Oct–Dec)

Eggs scattered on soil surface, mainly in grassland.

Larvae feed in winter whenever soil temperatures at night exceed 5°C.

Summer aphids

Grain aphid

Sitobion avenae

The aphids may be green, red or brown.

Rose-grain aphid

Metopolophium dirhodum

The aphids are green with a dark green strip along the body.

Life cycle

The grain aphid spends all year on cereals and grasses and may overwinter on winter cereals (see BYDV vectors). Fresh migrations infest crops from April onwards.

Colonies overwintering on crops tend to be infested by parasitoids. Grain aphid numbers may rise initially, but the parasitoids limit further population increase. Outbreaks tend to occur after colder winters which reduce natural enemies more than the more cold-hardy aphids.

Initially, grain aphids feed on leaves. During grain filling they move up to ears and feed from the phloem supply to grain.

Numbers increase most rapidly during settled, dry weather. They will increase until checked by crop senescence, unless reduced by heavy rainfall or natural enemies.

Life cycle

The rose-grain aphid overwinters as very frost hardy eggs on roses. It migrates to crops in spring.

Rose-grain aphids are susceptible to all grain aphids' natural enemies, so do not thrive in crops already colonised by grain aphids. After hard winters when both grain aphid and natural enemies are scarce, rose-grain aphid may cause problems.

These aphids remain on the leaves and do not move up to the ear.

Both species

Economic importance

Yield losses can reach 4 t/ha, but losses of 0.25–1 t/ha are more usual where populations exceed threshold levels. Only very severe infestations produce visible symptoms in crops.

Risk factors

All cereals are at risk. Winter barley is less affected due to its earlier senescence. Impact is greater where soluble stem carbohydrate reserves are low, eg drought-affected crops or crops damaged by other pests and diseases. Dry settled weather during early grain filling increases the risk.

Chemical control

Pyrethroids are the main choice to control ear infestations, but are less effective on earlier infestations on the undersides of leaves. Pirimicarb provides more selective control of aphids. Additionally, it has a vapour action which penetrates further into the crop.

Action thresholds

Treatments should only be considered if aphid numbers are increasing. Spray when:

- 50% tillers infested before GS 61
- 66% tillers infested from GS 61 to two weeks before the end of grain filling.

Cultural control

Measures, such as grass strips, proposed to increase natural enemies of crop pests, can provide harbourages for aphids. Wildflower strips with diverse grass mixture are less likely to harbour pests and will encourage parasitoids and hoverflies.

Natural enemies

Specific to aphids

Parasitic wasps, hoverflies, lacewings, ladybirds are attracted to aphid infestations and can provide control of potentially damaging numbers.

Some *fungal diseases* are also specific to aphids.

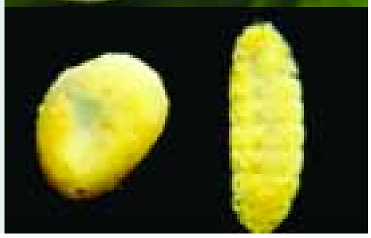
Polyphagous predators

Ground beetles, soldier beetles, rove beetles, spiders may help to mop up low numbers early in the season, thus slowing development.

Orange wheat blossom midge

Sitodiplosis mosellana

The orange-coloured larvae feed on wheat, barley and rye grain during grain filling. Larvae are up to 3 mm long. They lack legs, but have a prominent head capsule. Adult midges, also orange, and about 3 mm long, are found during ear emergence. They rest at the crop base during the day and fly up to the ears in the evening to lay eggs.



Economic importance

Each larva reduces grain size by 30–50%. Pericarp damage allows easier water entry, often resulting in sprouting in the ear and reduced Hagberg falling number.

Damaged seeds are susceptible to attack by pathogenic fungi, especially *Fusarium graminearum*; they may fail to germinate or produce weak seedlings.

Risk factors

Potentially damaging larval populations may be found in any field where wheat has been grown over the past five years. Higher soil populations are likely where wheat crops have been frequently grown during this period.

Crops growing in fields with high resident populations are more vulnerable to attack when weather conditions are marginal for flight.

Midges can fly half a mile or more in mild evening weather. They accumulate in the most sheltered fields at the vulnerable growth stage and attack new crops.

Natural enemies

The most important natural enemies are small parasitic wasps, especially *Macroglenes penetrans*. During the day they search for and lay their eggs in midge eggs. This does not reduce crop damage, as the parasitoid larva does not develop until the midge larva has overwintered.

Parasitism levels can exceed 80% and give useful control. By not spraying below threshold levels, parasitoid numbers may increase and provide longer-term midge control.

Polyphagous predators also kill adults and can kill larvae dropping to the ground if dry soil prevents them burrowing to safety.

Cultural control

- Reduce the frequency of wheat crops in the rotation in more sheltered fields.
- Grow resistant varieties, eg Welford.

Chemical control

- Apply chlorpyrifos to wheat crops within a week of finding a threshold number of midges laying eggs on the ears.

Pyrethroid sprays applied for aphid control may give some control of the midge if the timing coincides with flight, but this control is unreliable and not a label recommendation.

Action thresholds

Thresholds refer to numbers of midges laying eggs in the evening. The midges can be counted at night using a torch or in early morning. They fly off as temperatures rise.

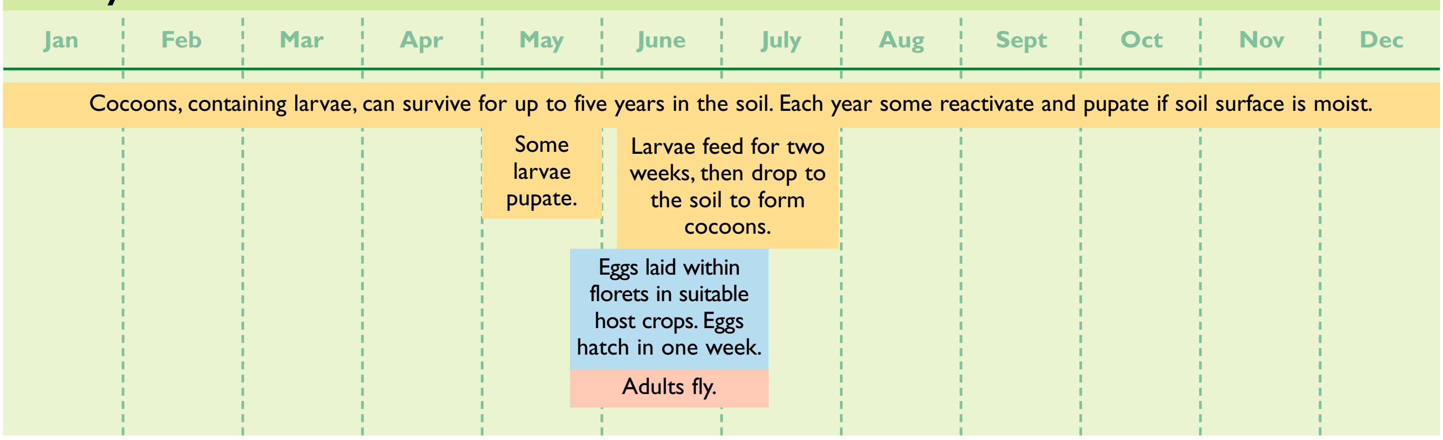
If several nights are suitable during ear emergence, count midges each evening and use the average figure.

- For feed crops – 1 midge/3 ears.
- For milling and seed crops – 1 midge/6 ears.

Consider using yellow sticky traps hung at ear height at the start of ear emergence to monitor activity. In crops at the threshold levels, expect to catch about 10 midges in each trap through ear emergence.

Ignore midge activity after the start of flowering, as eggs laid after this stage do not develop properly.

Life cycle



Peach-potato aphid

Myzus persicae

The peach-potato aphid feeds on oilseed rape, many other field and protected crops as well as weeds. Individuals may be green, yellow or light red. Like cabbage aphids, they are found under leaves.

Economic importance

Only very heavy aphid infestations cause direct damage. Numbers may increase after serious outbreaks of insecticide-resistant aphids on potatoes.

Aphids transmit the beet western yellow virus, which causes temporary reddening of infected plants in spring. Virus infections have been low in recent years.

Risk factors

Earlier-sown winter crops tend to be at greatest risk during warm autumns. Later-sown spring crops tend to be at greatest risk after mild winters.

Chemical control

Aphids that colonise crops in autumn may have survived through many generations on treated crops. This may lead to high levels of insecticide resistance restricting insecticide choice.

Three forms of insecticide resistance occur:

- Kdr resistance to pyrethroids
- MACE resistance to pirimicarb
- E4 strains resistant to pyrethroids, pirimicarb and OPs.

Seek expert advice on alternative insecticides if control is poor. Neonicotinoid seed treatments, such as Chinook, currently control all resistant forms for several weeks following emergence.

Life cycle

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

- Jan–Feb: Asexual females overwinter. Cold weather reduces survival.
- Mar–Aug: Adults infest other crops.
- Sept–Nov: Adults infest crops and transfer virus in mild autumns.
- Nov–Dec: Asexual females overwinter.

Cabbage aphid

Brevicoryne brassicae

This aphid is covered by grey, waxy scales. It is found under leaves and causes puckering and yellowing. Later infestations move on to developing flowers and pods.

Economic importance

The cabbage aphid carries turnip mosaic virus and cauliflower mosaic virus. Spring rape can become severely infested after mild winters and allow infestations on winter rape to increase to damaging levels.

Chemical control

A waxy covering protects cabbage aphid from contact insecticides, which can limit choice. Pyrethroid insecticides may not control cabbage aphid. Consider using use a higher rate of pirimicarb plus added wetter.

Action thresholds

Cabbage aphid may cause direct damage in spring if over 13% of winter rape plants or over 4% of spring rape plants are infested before petal fall.

Natural enemies

The parasitoid, *Diaeretiella rapae* normally provides good control.

Life cycle

Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July

- Aug–Oct: Infests winter rape.
- Oct–Feb: Overwinters on brassica plants.
- Mar–May: Multiplies rapidly when mild and may cause direct damage.

Cabbage stem flea beetle

Psylliodes chrysocephala

Adult beetles, 3–4.5 mm long, blue-black or light brown in colour, are sometimes seen crawling across the top of trailer loads of grain at harvest.

The adults return to crops just after emergence and chew ragged holes in cotyledons and early true leaves. Eggs are laid. On hatching, larvae bore into petioles and continue feeding close under the surface. These are distinguished from larvae of other pests by their black head and black plate at the tail end. Later, larvae move into the main stem to feed under the growing point.

Economic importance

Large numbers of adults feeding in the autumn kill plants, occasionally causing total crop failure. The pest originally attacked mustard and brassica seed crops in East Anglia. It now covers England and Wales and is spreading in Scotland.

Crushers may reject contaminated seed.

Risk factors

Earlier-sown crops often attract most cabbage stem flea beetle.

Warmer autumns favour egg-laying and earlier hatch of larvae.

Natural enemies

The main natural enemy is the wasp *Tersilochus microgaster*, which parasitises larvae in spring.

All parasitoids may be vulnerable to pyrethroids.

Parasitoids remain as pupae in the soil until the next crop, and may be damaged by ploughing. Minimum cultivation after rape favours parasitoid survival.

Cultural control

Delaying sowing reduces the numbers of adults attracted and of eggs laid.

Chemical control

Chinook seed treatment reduces adult feeding and numbers of eggs laid.

A pyrethroid spray should control feeding adults and larvae that have not entered the main stem. Treatments persist well through the winter.

One spray usually suffices.

Action thresholds

Consider applying an early pyrethroid spray if adults have eaten:

- over 25% of the leaf area at the 1–2 true leaf growth stage

or

- over 50% of the leaf area at the 3–4 true leaf stage
- the crop is growing more slowly than it is being destroyed.

If no adult spray applied, apply treatments to control larvae if:

- over 5 larvae/plant
- over 50% petioles damaged.

Life cycle

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
				Larvae pupate in soil.				Adults move to new crop, mate and eat leaves for a week or so.	Eggs laid at the base of plants if mild.	Eggs hatch.	
Larvae continue to hatch if mild and feed in petioles.					Adults emerge and feed on foliage.		Adults 'rest' in moist, sheltered places.			Larvae continue to hatch if mild and feed in petioles.	
		Larvae feed on main stem behind growing point.									

Other flea beetles

Wessex flea beetle
Psylliodes luteola

Attacks crops in the autumn.

Turnip flea beetles
Phyllotreta cruciferae, Phyllotreta nigripes, etc

Attack crops in autumn and spring.

Large striped flea beetle
Phyllotreta nemorum

Attacks crops in spring.

These beetles are smaller than cabbage stem flea beetle. Adults jump away when disturbed.

Economic importance

The Wessex flea beetle is of increasing importance in southern England. An initial outbreak in Wiltshire has spread to other areas. Crops can be severely checked.

Turnip and striped flea beetles are principally pests of spring brassicas.

Crop damage has increased following the withdrawal of lindane.

Risk factors

Wessex flea beetle is most likely to damage earlier sown crops, especially if slow to grow away in September.

Later sown spring crops are most susceptible to turnip and striped flea beetles. Any crops may be at risk if growth is checked by sunny, dry weather.

Natural enemies

There are some wasp parasitoids.

Cultural control

Delay sowing autumn crops and sow in a well consolidated seedbed to improve seed-to-soil contact and germination.

Sow spring crops as early as soil conditions and weather allow.

Chemical control

Chinook seed treatment may be used on winter, but not yet on spring, crops.

Pyrethroid sprays on growing crops only provide 3–4 days respite, but may help a crop survive until wetter weather returns.

Base spray decisions on same criteria as for cabbage stem flea beetle.

Action thresholds

No thresholds for treatment exist.

Life cycles

The life cycle of the Wessex flea beetle is not fully understood. Adults appear and cause damage in September.

Turnip and large striped flea beetles

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Hibernation	Hibernation	Migrate to crops and feed on leaves. Lay eggs at plant base.	Migrate to crops and feed on leaves. Lay eggs at plant base.	Migrate to crops and feed on leaves. Lay eggs at plant base.	Migrate to crops and feed on leaves. Lay eggs at plant base.	Adults emerge from late July. Direct feeding can damage crops.	Adults emerge from late July. Direct feeding can damage crops.	Hibernation	Hibernation	Hibernation	Hibernation
				Larvae feed on roots.	Larvae feed on roots.	Larvae feed on roots.					

Pollen beetle

Meligethes aeneus

These small, shiny, black beetles may arrive from the green bud stage onwards. They lay their eggs in the buds. Larvae later feed mainly on pollen in the flowers. Larvae have a head capsule and six legs.

Economic importance

Loss of pod sites from pollen beetle damage, albeit sometimes severe, rarely reduces winter oilseed rape yields. Crops usually compensate for earlier losses, producing more and larger seeds on lower racemes.

Varietal associations and restored hybrids may lose more yield because male fertile plants are attacked and cross-pollination is reduced. Spring crops are much more vulnerable than winter crops.

Risk factors

Pigeon and frost-damaged winter crops that remain at the green and yellow bud stages for longer are susceptible.

Varietal associations, restored hybrids and later-sown spring crops may also be at greater risk.

The use of 'canopy management' to optimise potential pod number may increase susceptibility to pollen beetle.

After all buds on winter crops have opened beetles migrate to other egg-laying sites, causing a second flush of migration to spring crops.

Spring crops are less able to compensate for damage than winter crops and so often justify treatment.

Natural enemies

Three wasp parasitoids commonly attack the larvae: *Phradis interstitialis, Phradis morionellus* and *Tersilochus heterocerus*.

Minimum cultivation after oilseed rape will enhance wasp survival.

Cultural control

- Sow spring crops as early as possible.

Chemical control

Resistant strains of beetles have appeared in France and Sweden. Investigate control failures to establish the level of resistance of the population.

- Only use pyrethroid sprays during green to yellow bud stages if thresholds are exceeded.

Larvae feeding in flower

Action thresholds

Apply chemical control measures if the thresholds are exceeded:

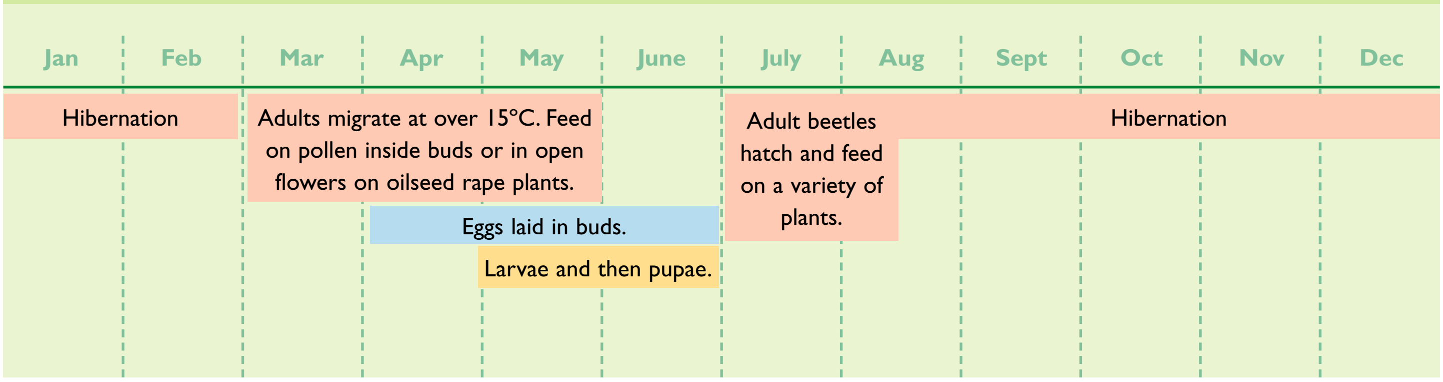
Winter oilseed rape

- over 15/plant at green-yellow bud
- over 5/plant for backward crops
- over 2/plant for varietal associations.

Spring oilseed rape

- over 3/plant at green bud. *(In Scotland 1/plant at green bud stage.)*

Life cycle



Cabbage seed weevil

Ceutorhynchus assimilis

This small black weevil with a curved snout lays its eggs into developing oilseed rape pods during flowering. A brown scar indicates the egg-laying puncture, usually causing a kink in the pod. One white larva with a brown head capsule develops inside the pod, eating the seeds.

Economic importance

Numbers rarely exceed damaging levels on winter oilseed rape. The pest is important in allowing entry of brassica pod midge. It may be more important on spring oilseed rape.

Risk factors

Cabbage seed weevil tends to be of greater importance in the northern britain.

Natural enemies

The parasitoids *Trichomalus perfectus, Mesopalobus morys* and *Stenomalina gracilis* generally keep numbers in check.

Cultural control

Delaying sowing of spring crops reduces numbers of adults attracted and of eggs laid.

Chemical control

- Apply a pyrethroid spray approved for use during flowering if the threshold is exceeded. This should be applied by petal fall and before too many eggs are laid.

Action thresholds

- over 0.5/plant in northern Britain
- 1/plant elsewhere.

Life cycle

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Overwinters as adults that fly into oilseed rape crops soon after flowers open.			The weevils lay eggs directly into the pod, chemically marking pods to deter any further egg-laying.			Larva develops within the pod, eating 3–4 seeds before burrowing out and dropping to the soil to pupate.		Adult weevils hatch in August and hibernate in non-crop situations.			

Brassica pod midge

Dasineura brassicae

These small, dark orange midges appear during flowering. They lay eggs through holes left by seed weevils in developing pods. Many small, white larvae with no obvious head occur in each affected pod. They cause swelling and eventually pod burst.

Economic importance

With damage greatest on headlands and affected pods very conspicuous, this pest can be over-rated.

However, spring oilseed rape yields can be severely reduced.

Risk factors

As the adult midge is a weak flyer, crops on headlands are more exposed to immigrant midges; thus largest yield losses often occur in small narrow fields.

Natural enemies

Several wasp parasitoids, including *Omphale clypealis* and *Platygaster subuliformis* may attack pod midge, killing up to 75% of larvae.

Cultural control

- Block oilseed rape fields and rotate the crop around the farm to reduce the impact of immigrant pests.

Chemical control

Sprays for seed weevil provide incidental control of pod midge by reducing egg-laying sites.

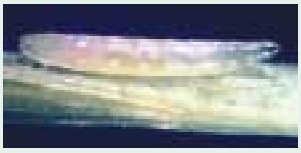
Action thresholds

No thresholds for treatment exist.

Life cycle

Larvae can hatch over a three-year period after rape. In June and July partial 2nd or 3rd generations attack late winter and spring rape.

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Larvae overwinter in cocoons in soil.		Adults emerge.		Adults mate. Fly to oilseed rape. Lay eggs in cabbage seed weevil holes or plant damage.		Larvae overwinter in cocoons in soil.					
					Larvae feed. Pods swell and burst. Larvae drop to soil. Some develop to give 2nd and 3rd generations of adults.						



Frit fly

Oscinella frit

There are three generations of frit fly a year, all of which can occur on ryegrass.

- First generation flies appear in May and lay eggs in cereal and grass stems. Larvae causing a classic deadheart symptom can severely damage late-sown spring oats.
- Second generation flies appear one to two months later and lay eggs in developing oat and wheat grains. Larvae then feed on the grain.
- Third generation flies hatch from harvested grain, sometimes causing a temporary nuisance in stores. Eggs may be laid on ryegrass, allowing larvae to transfer to any following winter cereal crops sown within five weeks of ploughing out the old ley.

Plough early if possible or control by chlorpyrifos sprays applied pre- or early post-emergence if the risk is high.

Thrips

Limnothrips cerealium
Limnothrips denticollis

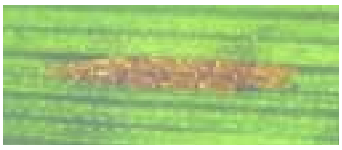
Thrips fly to cereal crops in May and lay eggs in the boots of emerging ears. Yield loss may follow if young thrips reduce sap flow by feeding on stems and flag leaf sheaths. Larvae also feed under the glumes and on developing grain causing black spotting, and possibly reduced flour quality.

Control measures are not usually justified.

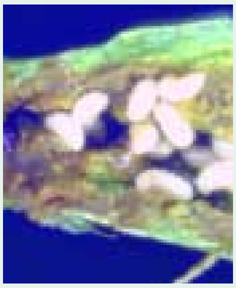
Saddle gall midge

Haplodiposis marginata

Blood-red coloured larvae hatch from eggs and feed under the leaf sheaf causing saddle-shaped galls. Damage restricts sap flow to the ear and can lead to lodging through stem breakage at the point of galling. Damage is most serious on cereal-dominated rotations on clay soils.



Adult midges lay rafts of red eggs on leaf surfaces in May.



Rape winter stem weevil

Ceutorhynchus picitarsis

Rape winter stem weevil adults lay eggs in the autumn. Larvae feed in the stem base through the winter. Large numbers may severely stunt the crop. Initially limited to Lincolnshire and Cambridgeshire, the pest has now spread to other areas.

Pyrethroid sprays applied to control cabbage stem flea beetle and aphid vectors are effective against this weevil.

Cereal ground beetle

Zabrus tenebrioides

This pest attacks crops in England, from Oxfordshire and Cambridgeshire southwards. Larvae burrow into soil, pulling down and eating shoots from October to May. Adult beetles feed on cereal ears before harvest and on spilt grain and stubble re-growths.

Damage is worst in all-cereal rotations and with minimal cultivations. A non-cereal break crop or early ploughing will provide good control.

Cabbage stem weevil

Ceutorhynchus pallidactylus

Stem weevils lay their eggs in oilseed rape stems in May. Larvae in large numbers can reduce seed filling and, in extreme cases, kill plants.

Adults are difficult to distinguish from those of seed weevil. For practical purposes assess together.

- Treat if threshold of 2 weevils a plant of any species, is exceeded.

BIOLOGICAL AND CULTURAL CONTROL

Many pests have natural enemies. Sometimes, these predators and parasites provide sufficient control to prevent any serious crop damage occurring. Some predators are specific to particular pests.

Enhanced use of natural enemies forms a part of 'Integrated Crop Management'. The deliberate introduction of predators is not viable in broad-acre arable crops.

Where natural enemy numbers are initially low, serious pest damage may occur. Pesticides may be needed to slow down the rate of pest increase and restore the balance between pests and natural enemies.

Broad-spectrum pesticides often control both pest and natural enemies removing the benefits of natural control. Often, pesticides are applied just after damage or infestations are identified. Such treatments will prevent beneficial pests from multiplying to populations that will significantly reduce pest numbers.

If a pesticide application is not fully effective – due to dose, timing, application technique or weather conditions – natural enemy numbers and their beneficial effects may be reduced. In such cases, more severe pest damage may occur due to reduced natural enemy numbers.

Rove beetle

Main natural enemies

Predator	Larvae eat	Adults eat	Comment
Parasitic wasps – Hymenoptera – Parasitica			
Parasitoid populations depend wholly on pest numbers, rising in response to outbreaks and declining as pest numbers fall.			
Endoparasites – live within and consume a single host individual.			
Stenomalus micans	Gout fly larvae	Nectar	Initially host larvae develop to full size. Then, parasitoid larvae start to feed, killing them before pupation. Parasitoids do not prevent crop damage, but can give longer-term population control if 80%+ of pest larvae are parasitised.
Macroglenes penetrans	Orange wheat blossom larvae		
Aphidius rhopalosiphi	Grain aphids	Nectar	Adult parasitoids are very sensitive to insecticides, so timing must be accurate.
Diaeretiella rapae	Cabbage aphids		
Ectoparasites – the larvae develop outside the host's body and may consume several individuals.			
Trichomalus perfectus	Cabbage seed weevil		The adult wasp inserts its egg through a hole bored into the pod by the weevil for egg laying.
Spiders – Araneae			
Erigone atra *Lepthyphantes tenuis*	Webs typically trap around 30% of aphids flying through the crop as well as wheat blossom midge adults and small flying insects.		Spiders are particularly vulnerable to pyrethroid insecticides.
Hoverflies – Syrphidae			
Syrphus ribesii *Episyrphus balteatus*	Each larva can eat c. 400 aphids on arable crops. A ratio of 1 larva: 30 aphids can control severe infestations.	Nectar 	Wild flowers in field margins attract hoverflies if local pollen sources are scarce. Oilseed rape and other flowering crops attract large numbers. Adult hoverflies feed on pollen.

Enhancing predator survival

Local management has more influence on predators than on pests. Many natural enemies survive in the soil, whereas many pests migrate to alternative habitats.

Parasites are favoured by minimum cultivation, although crop regrowth must be controlled to discourage pests and diseases.

In marginal habitats, the same management practices can encourage both predators and pests. A mix of diverse grasses and wild flowers should minimise pest carry-over.

Alternative host plants for many cereal pests, eg ryegrass or meadow grasses, should be avoided. Tussocky grass beetle banks may not be appropriate if beetle pests attack crops growing nearby.

Cultivation and agronomy

Cultivations can influence pest carry-over within a field:

- Effective destruction of the old crop, followed by a gap of at least five weeks, reduces carry-over.
- Soil consolidation can hinder pest movement from ploughed down residues to germinating seeds.

Rotations influence pest numbers available to attack succeeding crops.

Pest attack is often most severe at the edge of the field nearest to where the same crop was grown in the previous year. These edge effects can be minimised by growing several fields of the same crop together in a block. Rotations should be planned to maximise distances between fields or blocks of crops over succeeding years.

Predator	Larvae eat	Adults eat	Comment
Ground beetles – Carabidae			
Present in fields all year round.			
Pterostichus madidus *P. melanarius*	Slugs and other invertebrates	Slugs and other invertebrates	Also eat weed seeds and plants.
Trechus quadristriatus	Eggs of wheat bulb fly and cabbage root fly	Eggs of wheat bulb fly and cabbage root fly	Favoured by minimum cultivation and stubble re-growth.
Bembidion ustulatum	Springtails and other pests	Springtails and other pests	
Overwinter in field margins, flying adults forage in crops during summer.			
Demetrias atriapillus *Agonum dorsale*	Wide range of invertebrates	Cereal aphids and other prey in foliage	Partially control low aphid populations. Favoured by beetle banks and grass margins.
Soldier beetles – Cantharidae			
Cantharis fusca *Rhagonycha fulva*	Slugs and soil insects	Aphids and other pests	Adults hibernate off-crop.
Ladybirds – Coccinellidae			
Adalia bipunctata *Coccinella septempunctata*	Aphids	Aphids	Adults hibernate off-crop. Eggs are laid among aphids. Larvae are voracious and can reduce aphid populations.
Rove beetles – Staphylinidae			
Tachyporus hypnorum *T. obtusum*	Mildew and aphids	Mildew and aphids in cereals	Adults climb cereal stems at night. Hibernate in long grass in margins and beetle banks.
Aleochara bipustulata *A. bilineata*	Pupae of wheat bulb fly and cabbage root fly		Develop as parasites on fly pests.

Enhancing natural enemies

Field margin strips

Attract hoverflies and parasitic wasps; also provide food for wild birds, butterflies and bees.

Action

Sow a seed mixture containing grasses, eg fescues and bents, and wild flowers – use quite low seed rates to reduce costs. Plants of particular benefit for attracting hoverflies and parasitic wasps include cow parsley, hogweed, wild celery (umbelliferae) and yarrow, scabious and knapweed (compositeae). Margins are best sown on the east or north sides of fields to reduce hedgerow shading.

Do not

- sow ryegrass which harbours many pests
- sow umbellifereae, which attract many flies, if carrots, parsnips, celery or market brassicas are grown.

Beetle banks

Provide within-field hibernation sites for ground and rove beetles, spiders and nesting sites for ground-nesting birds, eg partridges and skylarks.

Action

Plough up rigs from opposing sides to create a bank splitting larger fields. Sow with tussock-forming grasses, eg cocksfoot, red fescue and timothy. Avoid spraying adjoining crop with insecticides. Beetle banks provide the greatest benefit in large fields where non-crop habitats are limited.

Do not

- use if cereal ground beetle is a problem.

Minimal cultivation

Enhances parasite activity on oilseed rape pests and survival of spiders.

Action

Use minimal cultivations, wherever possible, to enhance carry-over of natural enemies and enhance spider survival. Ploughing reduces numbers of natural enemies which pupate in the soil, eg parasitic wasps. Rotational ploughing is advisable where herbicide-resistant grass weeds or cereal ground beetle pose problems.

Do not

- use after oilseed rape if in an area prone to disease.

LERAP* and conservation headlands

Allow specific natural enemies, eg parasitic wasps, ladybirds, hoverflies and lacewings to build up on host pests.

Action

Follow label requirements for missing insecticide sprays on headlands in the summer and follow LERAPs guidelines for buffer zones near watercourses. Conservation headlands, with reduced broad-leaved herbicide use, enhance the benefit.

Do not

- reduce the buffer zone for pesticides with an A LERAPs classification (includes most insecticides)
- spray insecticides on a conservation headland after 15 March.

* *Local Environment Risk Assessment for Pesticides*

HGCA guides

Arable cropping and the environment – a guide, 2002

HGCA Topic Sheets

Posted free to levy payers on request.

32 **Minimising pesticide usage on cereals and oilseed rape**

38 **Dealing with wheat bulb fly**

39 **BYDV control based on aphid monitoring**

45 **Summer pest control on wheat**

48 **Seed treatments for pest control in winter oilseed rape**

HGCA Research Reviews (cereals)*

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28 **Orange wheat blossom midge: a literature review and survey of the 1993 outbreak**

33 **Impact of changes in arable agriculture on the biology and control of wheat bulb fly**

HGCA Project Reports (cereals)*

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53 **Research on slug behaviour: I The role of soil water in regulating the activity of terrestrial slugs II Cultural methods to reduce slug damage in cereals**

56 **Improving the forecast of BYDV high risk conditions in autumn-sown cereals**

67 **Control of wheat bulb fly in winter wheat: I Chemical methods II Varietal susceptibility**

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106 **Orange wheat blossom midge: survey of the 1994 outbreak**

110 **Determination of factors affecting grain aphid movement with reference to spread of BYDV in the autumn and winter and forecasting direct damage in the summer**

112 **Assessing modern cultivars of winter wheat for damage by the grey field slug**

120 **The epidemiology of a new leatherjacket pest (*Tipula oleracea*) of winter cereals in northern Britain**

129 **Key factors for modelling secondary spread of barley yellow dwarf virus**

135 **Aphid and virus dynamics to improve forecasts of barley yellow dwarf virus risk**

148 **Effects of polyphagous invertebrate predators on cereal pests**

155 **Aphid sex pheromones to enhance parasitoid efficiency**

173 **Integrated farming systems (a field-scale comparison of arable rotations) I Experimental work II The economic evaluation of input decisions**

198 **Evaluation of opportunities for dissemination of national pest and disease information**

205 **Development and validation of decision support methodology for control of barley yellow dwarf virus**

206 **The importance of barley yellow dwarf virus (BYDV) infection in spring barley and opportunities to manage the disease**

226 **Improving the efficacy of chemical control of wheat bulb fly**

229 **Appropriate aphicide doses for summer aphid control on wheat**

HGCA Research Review (oilseeds)*

OS1 **Insect pests of oilseed rape**

HGCA Project Reports (oilseeds)*

OS14 **The status and potential of parasitoids of seed weevil and pod midge on winter oilseed rape**

OS43 **Alternative seed treatments to gamma-HCH for controlling cabbage stem flea beetle on winter oilseed rape**

OS54 **Seed dressings to control slug damage in oilseed rape**

OS57 **The further development of seed treatments to control cabbage stem flea beetle and other pests on winter oilseed rape**

OS60 **Control of slug damage in oilseed rape by seed treatment – development and field tests**

Websites

HGCA:
www.hgca.com

Crop Protection Association:
www.crop-protection.org.uk

Game Conservancy Trust:
www.gct.org.uk

Leaf:
www.leafuk.org

Maltsters' Association of Great Britain:
www.ukmalt.com
(includes list of Agrochemicals accepted by the British Beer and Pub Association and Brewing Research International for use on malting barley).

Pesticides Safety Directorate:
www.pesticides.gov.uk

Rothamsted Insect Survey:
www.rothamsted.bbsrc.ac.uk/insect-survey/

Voluntary Initiative:
www.voluntaryinitiative.org.uk

Books

The UK pesticide guide, CAB International, 2003.

Pest and Disease Handbook, D V Alford, Blackwell Science, 2000.

Biocontrol of Oilseed Rape, D V Alford, Blackwell Science, 2003.

Legislation

In Great Britain, the storage, supply, advertisement, sale and use of pesticides are regulated by The Control of Pesticides Regulations 1986 (as amended) (COPR), The Pesticides (Maximum Levels in Crops, Food and Feedingstuffs) (England and Wales) Regulations 1999 (as amended) and in Scotland by The Pesticides (Maximum Levels in Crops, Food and Feedingstuffs) (Scotland) Regulations 2000, and commonly referred to as the MRL Regulations. Similar legislation exists in Northern Ireland. This legislation implements Part III of The Food and Environment Protection Act 1985 (FEPA).

*NOTE: *Project Reports and Research Reviews are available at cost from HGCA.*

Acknowledgments

This guide represents a knowledge transfer project. The guide describes general principles developed through HGCA and/or Defra-funded research.

Written by Jon Oakley, ADAS and edited by Dr Clive Edwards, HGCA; and Geoff Dodgson, Chamberlain.

The editors acknowledge the helpful comments made by many experts including: John Young, BASF; Dr David Cooper, Defra; Professor Graham Jellis, HGCA; Philip Morrall, Bairds Malt and Stan Sole, Crisp Malting on behalf of MAGB; Alan Bide and Steve Cook, Hampshire Arable Systems; Sue Mattock, Dr David Richardson and Martin Roberts, Defra PSD; Julian Hasler, NFU; Dr Richard Harrington, Dr Wilf Powell and Professor Ingrid Williams, Rothamsted Research; Dr Andy Evans, SAC Edinburgh; Michael Tate, Syngenta.

Design by Chamberlain.

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