Insecticide resistance status in UK cereal crops

Summary

- This publication by the Insecticide Resistance Action Group (IRAG) summarises the resistance status of aphid pests of UK cereal crops, and should be used in conjunction with IRAG's 'Insecticide resistance and its management' publication.
- Grain aphid (*Sitobion avenae*), bird cherry–oat aphid (*Rhopalosiphum padi*) and rose–grain aphid (*Metopolophium dirhodum*) are the main aphid pests of cereals in the UK.
- These guidelines apply primarily to the grain aphid, as this aphid is associated with insecticide resistance issues.
- Grain aphids with moderate levels of resistance to pyrethroids (conferred by the kdr mutation) are present in the UK, although there is substantial geographical variation in the frequency of the mutation. This has been monitored by testing grain aphid samples from the suction trap network. In 2020, 2% of the samples from the Starcross suction trap had the mutation compared to 71% of the samples from the York trap.
- Available insecticides in cereals that are effective against grain aphids include pyrethroids **applied at full label rates** and insecticides containing the active ingredient flonicamid (although this can only be used for summer infestations).
- There is no evidence of insecticide resistance in rose–grain aphid or bird cherry–oat aphid. Twenty-one bird cherry-oat aphid samples were collected from GB cereal fields between 2019 and 2020 and none showed reduced sensitivity to pyrethroids.
- To minimise the risk of insecticide resistance appearing and spreading, insecticide use should be minimised by adhering to aphid thresholds and IPM programmes. Products should be used at their **full label rate** and modes of action (MoA) should be alternated in the spray programme (where this is possible).
- Approved chemical names or the name of the chemical group they belong to are used throughout this document. The names of products registered in the UK that contain these insecticides are available at secure.pesticides.gov.uk/pestreg/ProdSearch.asp
- All IRAG publications can be accessed via the dedicated web page: ahdb.org.uk/knowledge-library/irag

Resistance status of aphid pests of cereals

Grain aphid, bird cherry–oat aphid and rose–grain aphid are the main aphid pests of cereals in the UK (Figure 1). Grain aphid is the main vector of barley yellow dwarf virus (BYDV) in the East, Midlands and the North. Bird cherry–oat aphid is the main vector of BYDV in the South West. All three species (especially grain aphid) can cause direct damage through feeding.

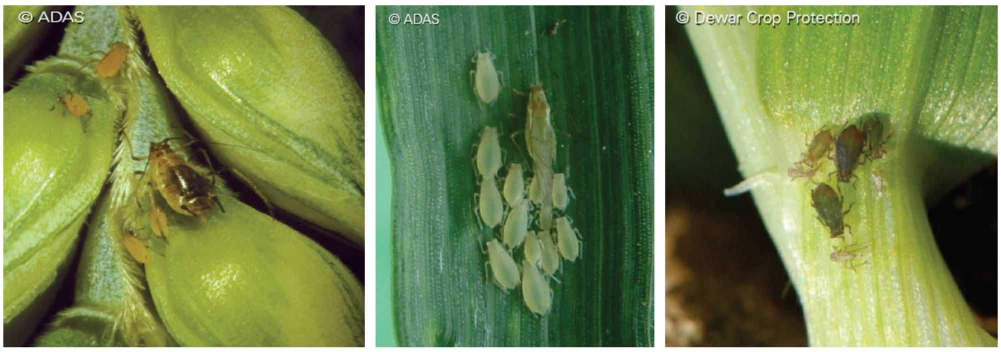

Figure 1. Effective resistance strategies require the target pest to be identified correctly. Images (left to right) show grain aphid, rose–grain aphids and bird cherry–oat aphid. For further information, see the AHDB 'Encyclopaedia of pests and natural enemies in field crops'.

In 2011, 'kdr' target site resistance was first identified in grain aphid. Initially, kdr was mainly limited to grain aphid populations in East Anglia. Samples from the suction trap network have subsequently been used to monitor its frequency and distribution. Testing in 2019 (Table 2), showed that the mutation was present in aphids from all the locations tested. The highest frequency recorded was ~30%. In 2020, a total of 340 *S. avenae* from 5 suction traps were tested. The kdr mutation was identified in aphids at all 5 trap sites, but the frequency of the mutation was highly variable between the traps. Samples from the Starcross and Brooms Barn suction traps were studied in both years and showed similar frequencies in 2019 and 2020. Further monitoring is needed to understand whether there is any seasonal variation in kdr frequency at any of the sites

Table 2. Grain aphid kdr testing results (NT = not tested).

Suction trap location	2019			2020		
	Number tested	Number with kdr	% kdr	Number tested	Number with kdr	% kdr
Starcross	100	7	7	120	2	2
Brooms Barn	92	2	2	64	4	6
Writtle	62	3	5	NT	-	-
Kirton	65	14	21	NT	-	-
Newcastle	56	17	30	NT	-	-
Hereford	NT	-	-	65	10	15
York	NT	-	-	65	46	71
Edinburgh	NT	-	-	26	5	19

To date, the kdr mutation has only been found as a heterozygous form (SR). Laboratory bioassays have shown that kdr as the SR heterozygote confers only moderate (30–40 fold) resistance to pyrethroids, and that kdr-SR aphids are still controlled effectively providing the full field rate is applied and good aphid contact is made (S Foster, unpublished). There are concerns that kdr homozygotes (kdr-RR), should they evolve, may be associated with stronger resistance, making them more difficult to control. In peach potato aphid, the homozygous form of kdr (RR) confers ~90 fold resistance to pyrethroids.

Current insecticide options for aphid control in cereals

Most cereal crops are treated for aphids. To maximise efficacy and to protect insecticides from resistance, it is essential to follow best practice measures. The measures, many of which are common across crop production, are detailed in the IRAG's 'Insecticide resistance and its management' publication. The document includes essential information on aphid monitoring. Further information on the MoA classification scheme can be found at irac-online.org/modes-of-action

Control in the autumn and winter

Only foliar-applied pyrethroids (IRAC 3A) are registered for control of BYDV aphid vectors in the autumn and winter. Initially, aphids colonise relatively few crop plants. When the second generation offspring are produced, these tend to move away from the plant originally colonised. Controlling this next generation is a key component of a BYDV/other virus management strategy. Spray applications should be considered once aphids have migrated into crops but before they have had a chance to spread virus from their initial colonisation point (usually mid-to-late October). Aphid migrations normally cease by early November, however they may continue into December if mild, dry conditions allow, as in recent years.

The timing of the second generation can be approximated by accumulating daily average air temperatures above a baseline temperature of 3ºC. It takes around 170 'day degrees' (DD) for the second generation to be produced. A tool to calculate when the 170 DD threshold is reached is available on the AHDB website (ahdb.org.uk/bydv), which takes into account region, crop emergence date and insecticide use.

Where grain aphid is identified as the main aphid pest present in the crop, pyrethroid sprays must be applied at the **full recommended rate** to maximise the effectiveness of treatment and to reduce the chances of grain aphid evolving stronger, control-breaking, pyrethroid resistance. It is also important to ensure good crop coverage, because pyrethroids only have contact activity against aphids. These actions will maximise control and minimise the selection of insecticide-resistant individuals.

Tank mixes of herbicides and insecticides are sometimes applied at the optimum time for weed control but not aphid control. Such approaches can result in poor aphid control and increase the risk of the crop being infected by BYDV and other viruses. Natural enemies can be important in controlling aphid populations. **Unnecessary** sprays of broad-spectrum insecticides, such as pyrethroids, will probably seriously damage natural enemy populations and reduce the important level of control they provide.

Control in the summer

Pyrethroids and flonicamid are approved for control of summer aphid infestations. As there is no evidence, to date, of resistance in rose–grain aphid or bird cherry–oat aphid, pyrethroids will be effective in controlling summer infestations from these pests.

Where grain aphid is the main species in a summer infestation, flonicamid is likely to be most effective. It is an insecticide with selective activity against hemipterous pests (such as aphids and whiteflies) and thysanopterous pests (such as thrips) and will have a lower impact on non-target, beneficial organisms (e.g. pollinators and natural enemies of aphids) than pyrethroid insecticides. Treatment efficacy should be monitored at a suitable time after application (this will be dependent on the active ingredients used but, generally, should be done after three days. Flonicamid, however, will take longer to kill aphids).

Other considerations for BYDV control

Weed control

Aphids can often be found on ploughed-down leaf material (e.g. grass weeds and volunteers). This material can act as a 'green bridge', which allows aphids to move up through the soil to newly emerging crops. Effective control of grass weeds and cereal volunteers, particularly in stubbles prior to seedbed preparation, helps reduce the risk of aphid movement.

Drilling date

Early drilled crops (e.g. drilled in September) are at the highest risk from BYDV. In most years, late-sown crops (i.e. drilled post mid-October), do not usually require a spray for aphid control. The exception is when warmer/drier weather conditions are conducive for aphid migration in late autumn.

Varietal tolerance

BYDV tolerant winter barley varieties are starting to be grown in the UK and wheat with BYDV resistance is also becoming available.

Further information

ahdb.org.uk/viruses-in-cereals-and-oilseeds

ahdb.org.uk/knowledge-library/encyclopaedia-of-pests-and-natural-enemies

Many principles of insecticide resistance management are common across crops and pest targets. These are detailed in IRAGs 'Insecticide resistance and its management' publication.

All IRAG publications can be accessed via ahdb.org.uk/knowledge-library/irag

Additional information on integrated pest management methods can be found in AHDB Cereals & Oilseeds Research Review No 86 (2016): ahdb.org.uk/a-review-of-pest-management-in-cereals-and-oilseed-rape-in-the-uk

Information on the resistance status of cereal aphids can be found in research reports:

114R480 Population genetic analysis of pyrethroid resistant grain aphid (*Sitobion avenae*) using high resolution microsatellite markers project

11120055 Pyrethroid Sensitivity in UK Cereal Aphids 2019-20.

21120077a Management of aphid and BYDV risk in winter cereals 2019–22