Agri Services

Bayer Expert Guide

Black-grass Management in Winter Cereals

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Introduction

Black-grass (*Alopecurus myosuroides Huds.*) (1), also known as slender fox-tail, black twitch, rat's-tail or mouse-tail grass (3,13), is just one of around 200 weed species responsible for 90-95% of weed problems worldwide (2).

During the late 1960s, the UK saw a substantial increase in continuous winter wheat growing throughout traditional cereal areas, with early-drilled crops and minimal cultivations becoming 'the norm'. These and other factors contributed towards an inevitable annual grass-weed problem, primarily from black-grass, wild oats, and later, bromes.

In spite of the availability of a range of effective products, both today and previously, black-grass still remains the major grass-weed and herbicide resistance problem on arable farms throughout the UK.

It is clear that for the long-term control of medium, heavy and resistant populations of black-grass an integrated approach is required. This involves a strategy of cultural, rotational and herbicidal methods for black-grass reduction. Only such a combined approach will offer the best chance of success in managing this widespread and difficult weed.

The aim of this guide is to raise the awareness and understanding of the problems associated with black-grass and its management in winter cereals.

A number of useful references have been used in the compilation of this booklet and these are listed at the end for those wishing to go into greater depth for the various subject areas covered.

Black-grass

Contents

1 Distribution of black-grass

Over the last four decades, the trend in continuous winter wheat growing has led to increasing infestations of black-grass in arable fields throughout England and other parts of North-Western Europe (1,6).

Black-grass is widespread, but not unique to Europe; it is also found in the Middle East, Asia (notably India and China), Australia and New Zealand, parts of the USA, and in Central and South America (2,3,4,5,7,23).

By 1973, it was estimated to infest over 200,000 hectares of the UK wheat and barley crop – mainly in England (17). Four years later, 54% of England's cereal farms were thought to have a black-grass problem (12), which by then had encroached onto lighter soils of the chalk downlands (18,21). In 1988, a survey of over 2,300 fields of winter wheat and winter barley showed black-grass to be the third most common grass-weed after annual meadow-grass and wild oats (15).

More recently a survey in 2011 of 1,350 arable farmers in Britain showed that 53% of farms applied herbicides specifically to control black-grass. The same survey also showed that black-grass had gradually spread further north with the greatest intensity of herbicide use still in the East of England.

The maps show the intensity of herbicide use for black-grass control in cereals in 2011 compared to 2006.

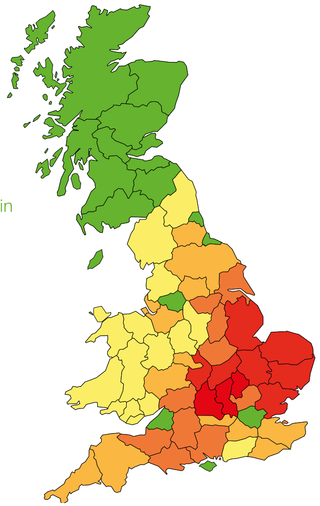

Figure 1: Intensity of herbicide use for black-grass control in winter cereals **2006**

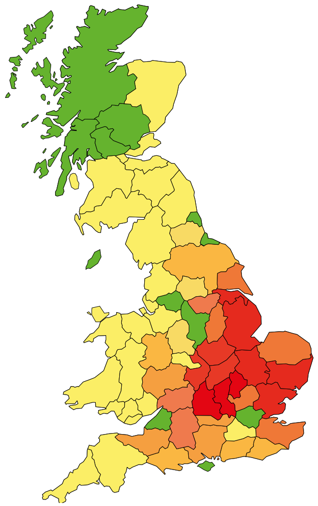

Figure 2: Incidence of spraying for black-grass **2011**

Key: Incidence of spraying for black-grass

Lowest Highest

2 Economic implications of black-grass infestations

Black-grass

Even at low densities black-grass can cause significant crop losses. Populations as low as 8-12 plants/m^2 have been shown to reduce winter wheat yields by 2-5% (27,28). On average, yield losses of 0.4-0.8 tonnes/ha can be expected in black-grass populations of 12-25 plants/m^2 (41).

Yield losses at higher black-grass densities are much more severe. Populations of 100 plants/m^2 can reduce yields of winter wheat by 1.0-2.0 tonnes/ha (19), and 300 plants/m^2 by up to 37% of total yield (19). Clearly, infestations of this magnitude need to be controlled before they reduce yields and set seed.

Results from field trials have shown that yield loss was usually greatest with earlier cereal drillings due to the higher competitive effect from each black-grass plant (10). Nevertheless, early drillings can also allow crops to establish much quicker and a vigorous crop can do much to compete effectively with black-grass (28,38). More prostrate and heavily tillering crop varieties can also compete with black-grass and so help reduce infestations.

In dense infestations, black-grass can cause severe lodging resulting in slower harvesting and poor grain quality. It can also host a range of cereal diseases including deadly ergot (*Claviceps purpurea*) and pests such as aphids and gall midge (7).

Other autumn-sown crops, including oilseed rape and field beans, can also suffer under high density black-grass populations, but rarely to the same extent as cereals. In spring-sown crops black-grass is much less of a problem.

Once black-grass gains a foothold in winter cereals, dense or herbicide-resistant black-grass will be more expensive to control than most other annual weeds. Whether it is in the extra cost of ploughing versus cultivations, spraying off stale seedbeds, reduced yields from delayed drillings, less profitable break crops to help guard against resistance, the use of higher seed rates, spring crop rotations, or purely increased herbicide use – the costs will all be greater because of the black-grass element.

3 Reasons for the spread of black-grass

The build-up of annual grass-weeds can happen rapidly, sometimes over just a few seasons. Managing or eradicating them can take much longer and in the long-term prove very costly.

Black-grass is an annual grass and propagates from seed. The large quantities of seed produced enable it to proliferate quickly year-on-year if conditions are favourable and control is ineffective.

Black-grass

Over the years, the spread of black-grass has been encouraged by one, or more, of the following factors:

1. Increases in the area of continuous winter cereals (20)
2. No rotations to utilise other autumn or spring crops (7)
3. Earlier sowing of cereals, favouring black-grass germination and seedling emergence
4. Non-inversion tillage or minimum cultivation techniques, without using stale seedbeds
5. Home-saved seed contaminated with black-grass and other weed seeds
6. Over reliance on herbicides alone for weed control
7. Increase in incidence of black-grass resistance to the herbicides used in cereals (44)
8. Poorly drained or compacted soil, favouring the growth of black-grass over cereals, particularly wheat (7,29)

4 Growth habit, biology and characteristics of black-grass

Black-grass is essentially a weed of arable fields. It is very rare to find it in long-term pasture, at the base of hedgerows or in ditches (19).

It favours heavier moist soils, or those with a higher proportion of fine particles (7) and is therefore ideally suited to many autumn-sown cereal-growing areas, particularly those for winter wheat.

Mature plants are 20-80 cm tall with erect hairless leaves. Leaf sheathes are smooth green – though more likely to be purplish around the base. The blunt, finely toothed, membranous ligule is 2-5 mm long.

Black-grass usually flowers from May to August, although emerged seed heads can sometimes be found in April. The panicles (seed heads) are spike-like, from 2-12 cm long and 3-6 mm wide, tapering towards the top. They are sometimes pale green, but more often purplish in colour when immature (3). Plants can exist as single shoots or tillered clumps, depending on the competitiveness of the crop and the germination date of the black-grass, i.e. late spring emerging plants can produce few, or no tillers. Single plants typically produce from 2 to 20 heads – although up to 150 heads have been produced in open situations without competition (7). Seeding normally commences in mid-June (peaking in July) and finishes by mid-late August.

Black-grass has the capacity to produce huge numbers of seeds – some infestations produce in excess of 1,000 heads/m^2. Each seed head has the ability to produce at least 80-150 seeds (22). These seeds are generally dormant when they are shed; this innate dormancy however, tends to be short-lived (7).

The viability of these seeds may be anything from 12-82%. In practice however, the successful emergence of seedling black-grass from the viable seeds shed is more likely to be only around 12-18% in the field (25). Whilst large numbers of seeds are produced, about two thirds of those shed on the soil surface suffer from fungal attack or are predated (24).

Germination of black-grass seeds is stimulated by light, and with moisture and warmth, emergence of seedlings is optimised at around 15 °C (26,29).

Around 80% of seedling potential will emerge in the autumn (6,7). Whilst this pattern is dependent on both soil and climatic conditions, in the majority of instances black-grass emerges along with or before the crop. Later germinating black-grass tend to tiller less, are less competitive and shed fewer seed than those germinating in the early autumn. However, under extreme drought or wet conditions, germination can be delayed until the following spring (7). When this occurs the actual number of plants emerging is frequently lower than would have emerged in a more favourable autumn.

In general, the majority of black-grass seedlings in a field come from seeds germinated in the top 5 cm of soil; typically the depth at which most are found following tine or minimal cultivations (25).

Ploughing however, buries the seed deeper and ‘out of harm’s way’ for the next season, although some viable seeds may be returned to the soil surface if the land is ploughed in subsequent years (21). Buried seeds have the ability to remain dormant in the soil, in some cases for up to 11 years (7), although further cultivations may break this dormancy, resulting in emergence of black-grass (25).

Survival of buried seeds in the soil is about 20-30% per year, so after 3 years of burial only about 1-3% of seeds will be viable – although this may still represent a considerable number of seeds (41).

Black-grass is also well equipped to deal with cold weather and larger plants are able to survive very low soil temperatures, down to -25 °C. Smaller plants can be killed at -8 °C. Growth ceases totally at around 2 °C (29) but active growth is reduced as temperatures decline to this level.

Seeds have a relatively short period of innate dormancy (several weeks) although this is reduced when seeds mature under hot/dry conditions (45).

5 Integrated black-grass control: cultural, cropping and chemical options

Control of medium to high density populations of black-grass should not be totally reliant on herbicides, especially where resistant populations are likely to be present. The strategy for long-term control of heavy black-grass infestations needs to be planned looking some years ahead.

Black-grass

Integrated cultural and rotational control, coupled with an effective herbicide programme and resistance management strategy is the only effective way to combat the long-term spread of black-grass – particularly where high populations were poorly controlled in the previous crop (43).

Where there are heavy infestations of black-grass (greater than 100 plants/m^2), annual control needs to be in excess of 95% (where using tine cultivations) (19); and around 80% (where ploughing is carried out) (25) just to contain the weed population at its current level. To prevent seed return control must be consistently greater than 98%, which is especially important where herbicide resistant populations are present. The ultimate aim should be to prevent these surviving plants producing seedlings in the next, or subsequent crops.

Black-grass

5.1 Actions to be taken before harvest

In May/early June look for the seed heads of any uncontrolled or surviving patches of black-grass in the crop.

- Mark or map these patches
- Assess the scale of the problem and if the patches are small enough, consider spraying off with a non-residual, non-selective herbicide to prevent seeding
- Look for obvious reasons for their presence, e.g. missed strips where spray nozzles have been blocked or not overlapped, high levels of chopped straw, water-logging etc.
- Eliminate any other possible reasons for poor herbicide performance, e.g. weeds not actively growing at application, conditions too cold, moisture stress, wrong timing, inappropriate dose rate for size of weeds etc.
- Get another opinion from your agronomist or product manufacturer, do not automatically suspect herbicide resistance
- When ripe, collect about a cupful of mature seeds from the black-grass heads in the patches and have them tested for resistance to herbicides. For further details see the Herbicide resistant weeds section

5.2 Cultural considerations

Whilst ploughing is a slower and much more expensive method of cultivation than heavy disc or stubble cultivations there is evidence to show that it can significantly reduce heavy black-grass populations in the next crop (28,30).

A five-year study comparing various cultivation regimes over four winter wheat crops showed the benefits of ploughing. The emerged black-grass population in the subsequent crop of oilseed rape (5th year) was reduced by 86% where ploughing was used in preference to four years minimal cultivation. When three years of minimal cultivation were followed in the last year by ploughing, black-grass was reduced by 79%. Although the least effective, a regime of three years ploughing and one of minimal cultivation still gave 63% reduction in black-grass plants, compared to four years of minimal cultivation. In this study the population of black-grass after four years of minimal cultivation without ploughing was 296 plants/m^2 (31).

Other field trials and computer modelling have also shown that ploughing regimes can slow down both the build-up of black-grass populations and resistant individuals by up to three times, compared to situations where continuous tine cultivations are employed (33).

A review of published literature concluded that ploughing achieved a mean level of 69% control of black-grass although control levels ranged from 82-96% (46).

Where necessary, rotational ploughing before drilling winter cereals will almost certainly reduce the potential black-grass problem before starting the chosen herbicide strategy, particularly where poor control was achieved in the previous crop. To be effective as a control measure the quality of ploughing should be good enough to ensure total inversion of the 'furrow slice' to give adequate burial of the black-grass seeds.

5.3 Cropping considerations

Delayed drilling and competitive crops

By creating a bigger 'window' between harvest and sowing the next crop of cereals, a higher level of black-grass is likely to emerge before the crop/drilling.

If properly integrated into this, cultivations (particularly with 'discs') can be an effective tool to aid black-grass control. Later non-inversion cultivations, in October rather than September, can be as effective as ploughing for reducing black-grass populations. As long as there is sufficient moisture for germination, black-grass can be sprayed off with a non-residual, total herbicide, once there is good emergence of seedlings (28). Germination of black-grass for control prior to drilling can be enhanced by the creation of a 'stale seedbed'. This strategy works best when hot/dry conditions in June and July cause the seeds to mature with lower dormancy levels, ensuring an increased and more rapid germination of black-grass. In contrast, cool, damp conditions around maturity may create a longer dormancy period in the black-grass seeds (34).

There is however, an element of risk attached to this strategy, as later drilling may result in a yield penalty or difficulties in establishing crops if the weather turns wet. Out of necessity the best option in this situation may well be to drill the fields with the heaviest soils first. Where possible, however, plan to drill the worst black-grass fields last, having first reduced the black-grass pressure by cultivating and spraying off emerged weeds.

The choice of cereal cultivar can also have a significant impact on the competitiveness of the crop, with some varieties being up to four times better at suppressing weeds than others (39). Use of competitive varieties can provide 9-36% control of black-grass in winter wheat (41). Your agronomist/advisor may be able to provide an indication of their competitiveness with regard to aiding your black-grass control programme.

Autumn-sown crops, other than cereals

Planting crops, other than cereals, in the rotation can enable both different cultural methods and herbicides to be used, thus forming the basis of a strategy to reduce or delay the development of resistant black-grass populations. This also can spread the workload more evenly across the farm.

However, the penalty for this lies in lower potential profit from other crops such as winter field beans. Nevertheless, alternative autumn cropping may be worth considering, at least for the worst affected fields, if the black-grass infestations are heavy or resistant.

Rotations incorporating spring-sown crops

Rotational options, incorporating spring-sown crops, are often overlooked for the reduction of black-grass. Only around 20% of black-grass germinates between March and May (6), and competition from black-grass is usually considerably less in spring-sown crops than in autumn-sown cereals. Sowing a spring crop, if only in the worst affected fields, can give further opportunities to control black-grass, providing around 80% control in a winter wheat based rotation (41). Again, as is the case with alternative autumn-sown crops, the profitability of spring crops, e.g. oilseed rape, spring barley or linseed, is lower than that of winter wheat. In addition, depending on soil type and region, the establishment of spring crops can be problematic on some farms.

Before sowing a spring crop most of the potential black-grass problem should have been eliminated.

- Autumn stubble cultivations will have stimulated most black-grass to emerge and then have been sprayed off, or ploughed under
- Further seedbed preparations should help to eliminate any later germinating black-grass and other weeds
- Where necessary, the use of an appropriate 'in-crop' herbicide for grass-weed control should take into account any herbicide resistance strategy to be employed

The aim here should be to prevent any black-grass plants surviving to return seed to the soil for the next crop.

Fallowing, non-cropping or green cover on land not used for, or temporarily removed from, crop production

Fallowing, or land temporarily removed from production, also offers scope for black-grass reduction. Much research has been conducted on weed seed-banks and it has been shown that the black-grass seed-bank, in particular, can be depleted by 70-80% in the first year after seed has shed (38,41).

In all cases the absence of new seeding is essential either by use of non-selective herbicides or by cultivations.

Note: as permitted treatments for use on land removed from production can change, always check the current situation with Defra or your advisor.

Spraying

5.4 Chemical control of black-grass

It has already been shown that both appropriate ploughing and spraying off emerged black-grass seedlings with non-residual, non-selective herbicides offer good potential to reduce infestations before the next crop is sown.

Where this has not been possible, using a pre-emergence herbicide will reduce early weed competition and in some cases may 'sensitise' the black-grass for follow-up herbicide treatments, thereby ensuring good crop establishment and early growth without weed competition.

Where no pre-emergence herbicide has been applied and there are dense infestations of black-grass, best yield responses will come from herbicide treatments applied in the autumn or early winter, rather than in the spring (11).

It is important to keep accurate spray records of all products used on each field. These should be checked to ensure that herbicides having the same mode of action are not used as the sole treatment year after year on the same target, as this can lead to the build-up of resistant populations of black-grass (as well as other weeds).

For further information on managing and preventing herbicide resistance, consult the guidelines (43) issued by the Weed Resistance Action Group (WRAG), which are available from the HGCA, CPA, your distributor or cropping advisor. They can also be found on the Health and Safety Executive (HSE) website: http://www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/Resistance-Action-Groups/wrag

Herbicide resistant weeds

Populations of black-grass, wild oats, Italian rye-grass and other weeds have developed resistance to some herbicides. Controlling these infestations with herbicides has become increasingly difficult and costly, sometimes with less than adequate control being achieved.

Herbicide resistance was first recorded in England in 1982 (8,9) and was driven by the long-term usage of various herbicides for black-grass control. Since then, resistance to herbicides has steadily spread and is now reported to affect black-grass present on a major proportion of winter wheat in England and Wales, with thousands of confirmed cases, across most of the cereal producing counties in England (42). Herbicide resistance is likely to be present in most natural weed populations, initially at very, very low levels. When herbicides are applied to these populations the most susceptible are killed, leaving only a few individuals with a higher level of tolerance to the herbicide. By continually applying the same herbicides to the same target, this selection pressure gradually favours only the most tolerant or 'herbicide resistant' individuals, which will then multiply.

Source: S. Moss, Rothamsted Research

Figure 3

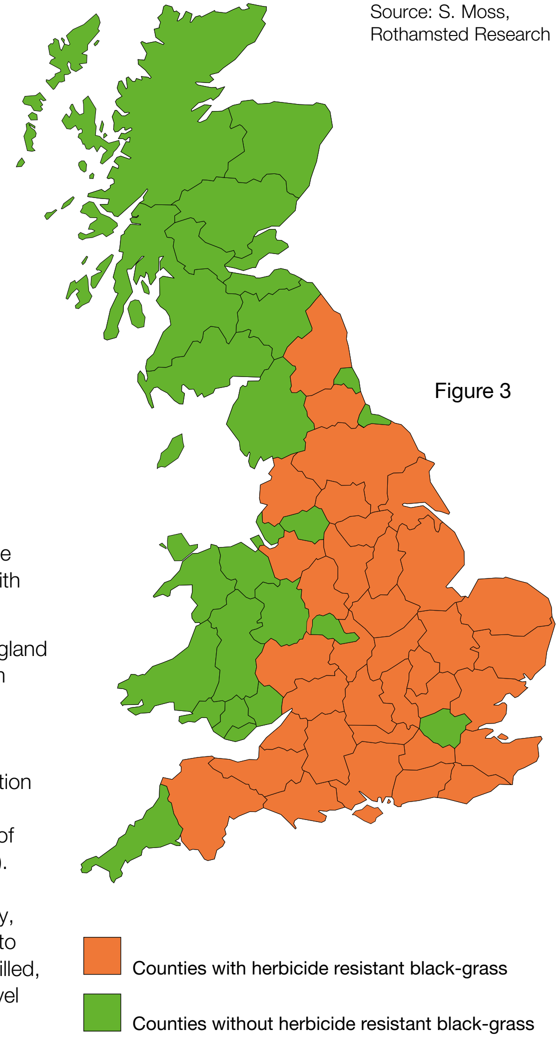

Figure 3: Counties with herbicide resistant black-grass (by 2013)

If not managed appropriately, the population will eventually consist of predominantly resistant biotypes. Where herbicide resistance is confirmed in a weed population, it is important to know the type of resistance that is present, either target site or enhanced metabolism.

Target site resistance – Occurs when the target enzyme on which the herbicide acts in the black-grass, mutates. As a result, the herbicide is no longer able to act or bind on to the target site to kill the plant. Where there is target site resistance to a particular herbicide mode of action then herbicides with that mode of action do not work at all – there are no half-measures. Target site resistance occurs for those herbicides that work on a single enzyme target, for example ALS inhibitors e.g. sulfonylurea herbicides, and ACCase inhibitors e.g. fop/dim/den herbicides. Examples of these herbicides are shown in Table 1.

Enhanced metabolism resistance – Occurs when the target plants are able to detoxify the herbicide, essentially by producing higher levels of enzyme. The herbicide is effectively de-activated by the excess enzyme before getting to the target site. With enhanced metabolism resistance, the herbicide usually works to some extent. There is, however, less flexibility relating to growth stage and other conditions that would normally be associated with acceptable levels of control. Currently, this is the most common resistance mechanism in black-grass in the UK and it is not specific to a particular herbicide mode of action. Hence, enhanced metabolism resistance affects the performance of a wide range of herbicides as well as ALS and ACCase inhibitors.

Enhanced metabolism resistance can also lead to **cross resistance**, where the higher levels of plant enzyme are able to detoxify more than one type of herbicide group. For example, resistant plants may be able to detoxify both ALS and ACCase inhibitors as well as other herbicide groups, including substituted ureas, triazines etc. When cross resistance is present in a black-grass infestation the situation is much more difficult to manage.

In order to prevent or delay the build-up of resistant weeds, herbicides within the same mode of action group, e.g. A, B, C1, C2 etc. (see Table 1), should not be applied more than once to control the same target weeds in the same crop. To do so would put a higher selection pressure on that population.

Table 1: Key grass-weed herbicide groupings, by mode of action and active

Group	Active ingredient	Chemical group	Mode of action
A	clodinafop-propargyl diclofop-methyl fenoxaprop-P-ethyl fluazifop-P-butyl* propaquizafop* quizalofop-P-ethyl* cycloxydim* tepraloxydim* tralkoxydim pinoxaden	**‘fops’** aryloxyphenoxy-propionates **‘dims’** cyclohexanediones **‘dens’** phenylpyrazolines	ACCase inhibitors Inhibition of acetyl CoA carboxylase
B	flupyrsulfuron-methyl iodosulfuron-methyl-Na mesosulfuron-methyl sulfosulfuron pyroxsulam propoxycarbazone-Na	**sulfonylureas** **triazolopyrimidine sulfonamide** **sulfonylamino-carbonyl-triazolinones**	ALS inhibitors Inhibition of acetolactate synthase
C1	metribuzin*	**triazinones**	Photosystem II inhibitors
C2	chlorotoluron	**ureas**	Photosystem II inhibitors
D	diquat*	**bipyridyliums**	Photosystem I – electron diversion
F1	flurtamone diflufenican	**Inhibitor of PDS**	Inhibition of pigment synthesis – carotenoid biosynthesis
F3	amitrole*	**Inhibitor of PDS**	Target site not known
G	glyphosate#	**glycines**	Inhibition of EPSP synthesis
H	glufosinate-ammonium*	**phosphinic acids**	Inhibition of glutamine synthesis
K1	propyzamide* pendimethalin	**benzamides** **dinitroanilines**	Inhibition of microtubule organisation
K2	carbetamide*	**carbamates**	Inhibition of microtubule assembly
K3	napropamide* flufenacet	**acetamides** **oxyacetamides**	Inhibition of cell division
N	tri-allate prosulfocarb	**thiocarbamates**	Inhibition of lipid synthesis – not ACCase inhibition

* Not for use in cereals
# Can be used for pre-harvest management in cereals
PDS – phytoene desaturase
EPSP – 5-enolpyruvylshikimate-3-phosphate

Key herbicides available for control of black-grass in winter cereals

The information contained within this sub-section is for information only and does not constitute a specific recommendation for the control of black-grass or other weeds in winter cereals.

Restrictions may apply to application timings and following crops etc. In all instances either check with your advisor or follow guidelines provided in product literature and on the product label. Individual products must be applied in accordance with directions and restrictions on the product label. Always read the label and product information before use. Use plant protection products safely. Where tank-mixes are used, the manufacturers' recommendations should always be followed.

Below is a summary of the main features of key active ingredients currently used for the control of black-grass (and other grass-weeds) in winter cereals.

Stubble treatments, pre- or post-cultivation, pre- or post-seedbed preparation

Glyphosate and glufosinate-ammonium – These post-emergence, non-selective, non-residual herbicides can provide a high level of control of emerged seedlings. Use after initial cultivations when moisture has stimulated the germination of black-grass and good weed seedling emergence has taken place.

Residual herbicides

Residual herbicides can provide control of black-grass emerging after application and as such are a valuable component of an autumn control programme when applied either pre-emergence or early post-emergence. In addition, pre-emergence herbicides are generally a lower resistance risk than post-emergence herbicides. For any soil acting herbicide, seedbed preparation is particularly important to get the optimal level of control. Accumulations of chopped straw or crop residue should be buried, or spread as thinly as possible, following cultivation. Ideally clods should be smaller than 2-3 inches (5-8 cm) in diameter and the seedbed consolidated. For pre-emergence applications a moist soil surface with some rainfall soon after application will also help maximise the level of control provided.

Flufenacet – Flufenacet is available in mixtures, e.g. with diflufenican as 'Liberator'. A residual herbicide which is most effective when applied pre-emergence of black-grass. Liberator currently provides the most effective start to a black-grass herbicide programme typically giving 60-80% control of black-grass emerging in the autumn. As the efficacy of flufenacet is not affected to any great extent by herbicide resistance it is a valuable component of any resistance management strategy.

Pendimethalin – A residual herbicide which should ideally be applied pre-emergence for optimal black-grass control. Whilst its efficacy is reduced by high levels of enhanced metabolism resistance, it continues to be effective on all but a few localised populations and is widely used as a component of black-grass control programmes.

Flurtamone – A residual herbicide which is most effective when applied pre-emergence of black-grass. Whilst less effective than flufenacet for the control of black-grass, flurtamone provides an alternative mode of action for black-grass control and flurtamone based products can contribute to an overall black-grass control programme. Flurtamone is available only in mixtures, e.g. with diflufenican as 'Bacara' and with flufenacet and diflufenican as 'Movon' and 'Vigon'.

Tri-allate – A soil applied residual herbicide which is most effective when soil is incorporated. It provides a useful alternative mode of action to aid with resistance management and can provide a useful component of an overall programme for black-grass control.

Prosulfocarb – Exhibits residual efficacy against black-grass, but is less effective than flufenacet. It is most effective when applied pre-emergence and when tank-mixed with an effective residual herbicide, e.g. flufenacet.

Flupyrsulfuron – A sulfonylurea herbicide previously used mainly for the post-emergence control of black-grass in winter wheat. An ALS inhibitor, active by a combination of foliar and root uptake, its efficacy is enhanced by moist soil conditions. It has limited residual efficacy against black-grass. The level of black-grass control provided has declined in recent years due to the increase in levels of enhanced metabolism resistance on many farms. Nevertheless, when applied pre-emergence of black-grass (typically in tank-mix with another pre-emergence herbicide) it can provide additional control of black-grass populations. As an ALS inhibitor herbicide, a strategy should be implemented to prevent the potential for continued build-up of herbicide resistance on farm.

Diflufenican – A residual herbicide traditionally used for control of broad-leaved weeds. Whilst relatively ineffective if used alone, when applied in tank-mix or co-formulation with black-grass residual herbicides (e.g. flufenacet or prosulfocarb) it can provide an additional 5-10% control.


Spraying

Post-emergence herbicides

Mesosulfuron – A sulfonylurea herbicide for the post-emergence control of black-grass (and other grasses) in winter wheat. Active primarily via foliar uptake, it is readily translocated and has limited residual efficacy. It currently provides the most robust post-emergence treatment for black-grass control. However, as an ALS inhibitor herbicide, a strategy should be implemented to prevent the build-up of herbicide resistance on the farm. Mesosulfuron is available only in mixtures, e.g. with iodosulfuron as 'Atlantis WG' and as 'Pacifica'. For further details on the use of Atlantis WG for control of black-grass in winter wheat, see page 22 of this guide.

Pyroxsulam – A triazolopyrimidine ALS-inhibiting herbicide for the post-emergence control of black-grass (and other grasses) in winter wheat. It is a contact acting herbicide with negligible residual efficacy. Pyroxsulam is available only in mixtures, e.g. with flupyrsulfuron or florasulam for enhanced black-grass control. Apply early post-emergence and use in programmes and mixtures to give effective control of black-grass. As an ALS inhibitor, a strategy should be implemented to prevent the build-up of herbicide resistance on the farm.

Clodinafop-propargyl – A foliar applied, translocated herbicide providing post-emergence control of black-grass, but with no residual control. Its efficacy is affected by both enhanced metabolism and target site (ACCase) resistance, the latter of which has been reported to be present, to some extent, on around 80% of farms with black-grass in England. Where target site resistance (ACCase) is not present, clodinafop can help to provide useful levels of control of emerged black-grass when applied early post-emergence in tank-mix with other effective herbicides. A mixture with prosulfocarb is available providing some residual control of black-grass emerging after treatment.

Pinoxaden – A foliar applied, translocated herbicide with no residual activity. Its efficacy is affected by both enhanced metabolism and target site (ACCase) resistance in black-grass. It provides only low-moderate levels of black-grass control in most situations and is not specifically recommended for black-grass control in winter wheat. However, pinoxaden does provide one of the few options for post-emergence black-grass control in barley.

Wheat

6 Use of Atlantis WG for control of black-grass in winter wheat

Atlantis WG is a broad-spectrum post-emergence grass-weed herbicide which delivers the most effective and most consistent control of black-grass when used appropriately. However, to maximise its performance and to ensure sustainable future grass-weed control, only use Atlantis WG as part of an integrated control programme utilising both cultural and chemical techniques.

This section provides a brief summary of the information relating to the effective use of Atlantis WG (mesosulfuron-methyl + iodosulfuron-methyl-sodium).

To optimise the performance of Atlantis WG, it should not be used as a standalone treatment, unless following a robust non-ALS pre-emergence herbicide programme and part of an integrated weed control strategy. The following table offers guidance on appropriate herbicide programmes.

Black-grass status	Pre-emergence	Post-emergence*
Normal	Product delivering 240 g ai/ha flufenacet (e.g. 0.6 L/ha Liberator)	At 1-3 leaf of black-grass apply Atlantis WG and biopower plus an effective residual herbicide based on – flufenacet 120 g ai/ha i.e. 0.3 L/ha Liberator – prosulfocarb – pendimethalin
Difficult	Product delivering 240 g ai/ha flufenacet (e.g. 0.6 L/ha Liberator) in tank-mix with: – prosulfocarb – diflufenican – pendimethalin	At 1-3 leaf of black-grass apply Atlantis WG and biopower plus an effective residual herbicide based on – flufenacet 120 g ai/ha i.e. 0.3 L/ha Liberator – prosulfocarb – pendimethalin

*Abide by any label restrictions relating to sequences of residual herbicide options with pre-emergence treatment applied

6.1 Best use guidance for Atlantis WG

- For the best and most consistent grass-weed control apply Atlantis WG at 400 g/ha at GS 11-13 of the grass-weed when the majority have emerged, which on average is in the autumn
- Atlantis WG should be tank-mixed with an effective residual partner when applied in the autumn and always with the adjuvant 'biopower'
- Build robust herbicide programmes based on sequences with Atlantis WG – an effective pre-emergence residual treatment is vital to get on top of black-grass and reduce pressure on Atlantis WG
- Atlantis WG should be applied to actively growing weeds for maximum efficacy
- Atlantis WG applied in the spring or beyond GS 11-13 is more likely to result in sub-optimal application conditions which can significantly reduce profitability through poorer control and/ or reduced yields
- Where a compromise on application timing has to be made, greater efficacy will be obtained where applications are applied going into a cold period rather than coming out of one
- Resistance is becoming more widespread and so responsible stewardship is critical

6.2 Key aspects of the Atlantis WG resistance management strategy

- Maximise the use of cultural control techniques such as stale seedbeds, delayed drilling, crop rotation and competitive crops
- Control weeds when they are at the 1-3 leaf stage and most vulnerable to Atlantis WG
- Always apply Atlantis WG at 400 g/ha
- Always apply Atlantis WG with the adjuvant 'biopower'
- Never use any other grass-weed active ALS-inhibiting herbicides in sequence or tank-mix when using Atlantis WG unless approved by CRD
- When using a residual partner, always use an effective product at an effective dose
- Use in sequence with effective non-ALS herbicides
- Monitor weed control effectiveness and investigate any odd patches of poor grass or broad-leaved weed control. If unexplained, a resistance test may be appropriate

Black-grass in wheat

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