Winter Wheat and Barley: The Integrated Management of Broad-leaved Weeds and Meadow-grass

SAC

Technical Note

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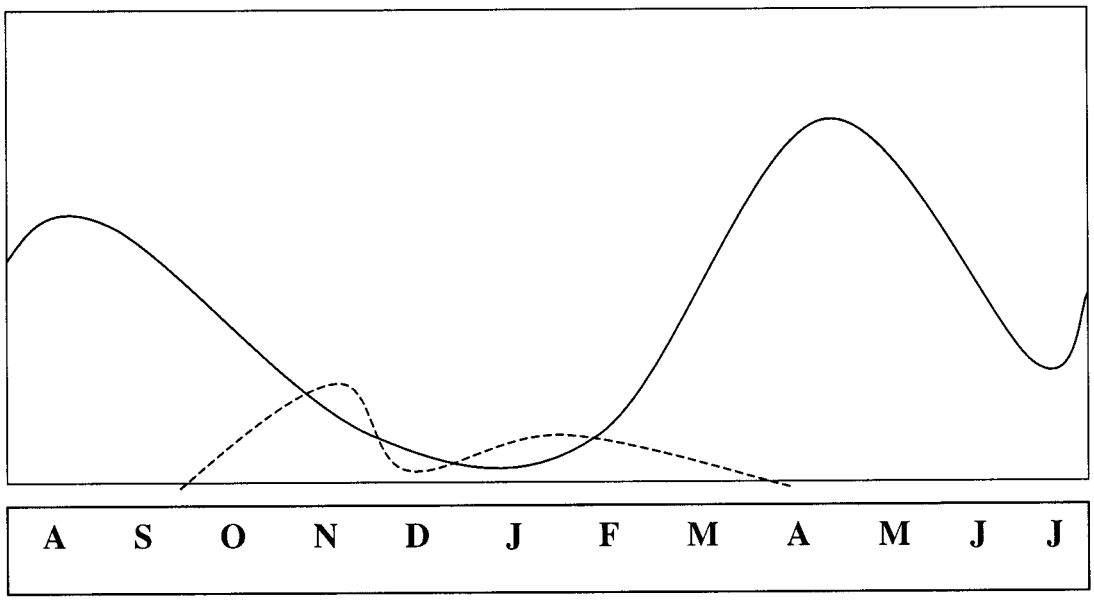
Summary

- Weed growth in winter wheat and barley depends on sowing data, methods of cultivation, crop cultivar, and crop vigour and shading at key points in the season.
- Good crop growth improves in-crop weed control, whether by cultivation or by use of herbicides.
- Early sown crops require autumn weed control treatments, whereas late sown crops often do not need treatment until spring.
- Reducing cultivations before sowing reduces some broad-leaved weed emergence, but does not effect cleavers, and increases groundsel, mayweed and meadow-grass problems.
- Weeds vary in their competitiveness and when they are competitive. Some weeds are not highly competitive but can cause harvesting and grain contamination problems. Cereal crops can be used to reduce the weed seed burden of a number of species difficult to control in other crops.
- Methods of cultivation for weed control and herbicides are reviewed.

The Weeds and Crops

The figure below outlines the general weed emergence pattern that is expected over the winter cereal season (the dotted line represents cleavers). It is clear that the later a crop is sown in the autumn the fewer autumn weeds emerge, but the more open the crop is to spring weed emergence. The later the crop growth stage in early spring, the more shading there is from the crop canopy and the less fresh weed emergence can occur. Winter barley sown in early autumn can be very shading in the spring compared with winter wheat, which even when sown early has a more open crop canopy in the early spring. Crop canopy development also depends on cultivar type; for example an EU-funded programme at SAC in organic systems is also showing differences in weed suppression due to differences in crop shading (Figure 2).

Figure 1. Pattern of annual broad-leaved weed emergence over the winter cereal growing season



This can have an impact on weed control as shown by a DAFS funded trial in 1993 which indicates for winter wheat cultivars, the greater the early ground cover, the less weed emergence and vigour and the better the herbicide activity in the Spring (Table 1). It may also reduce the number of cultivations needed in ICM and organic regimes.

Table 1. Effect of wheat variety early ground cover on the amount of metsulfuron + mecoprop-p required to give 95% control of broad-leaved weeds in an SAC trial.

	Earliness of ground cover 9 = early	% of full dose or 95% weed control
Parade	5.0	›50
Slejpner	7.0	42
Fortress	7.0	47
Mercia	8.0	36
Apollo	8.7	18

There is still a lot of research to be undertaken before the best cereal varieties can be selected, but good early ground cover at late tillering and good late shading at the flag leaf timing on the main stems with a planophile (horizontal) leaf structure are probably important factors. There is some evidence from studies at the University of Bonn that sowing in an East-West direction also increases the degree of shading in the crop, particularly in the spring and may reduce weed growth. However, this is the subject of further research as to its value under northern solar inclinations in the spring.

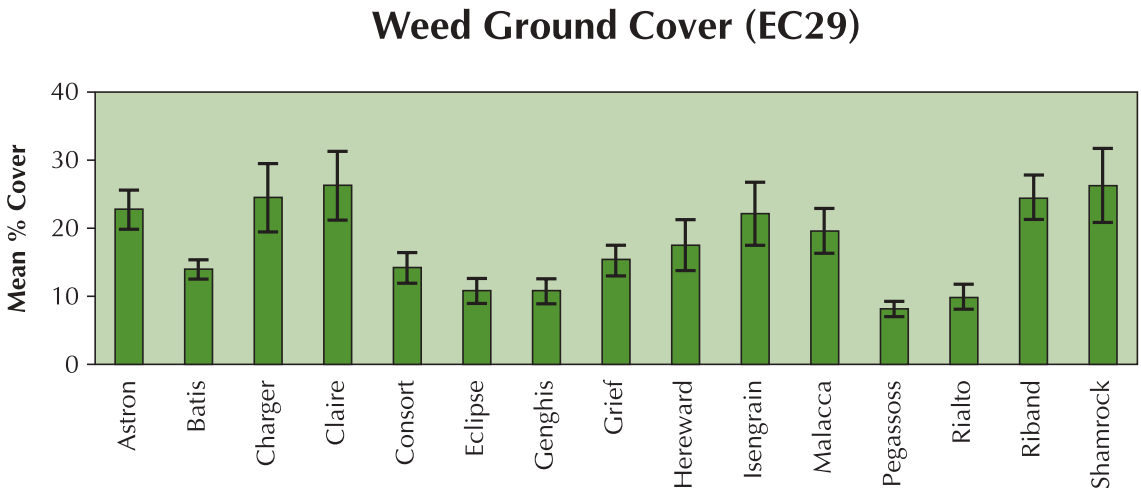
Row width does have an effect on shading, but in EU-funded trials in organic wheat at SAC in 2001 there was relatively little difference in weed growth in rows between 11 and 16cm wide, but increasing significance as rows widened to 22cms. The value of wide rows is to allow for easier inter-row cultivations, but yields can be affected, and when herbicides are used then narrow rows are preferable to increase shading to reduce weed growth, and potentially the amount of herbicide used.

These factors related to crop architecture are key to good broad-leaved weed suppression by the crop, most particularly in the spring, but also in the autumn in early sown crops. There is, however, an increasing tendency to sow wheat as early as barley, and wheat may not be as competitive early on because of its narrower young leaves. Early sown wheat also does not have the canopy development of early sown winter barley in the spring, so is more subject to both autumn and spring weed flushes than winter barley.

Crop Vigour and Yield Responses

Work at SAC comparing September sown barley with October sown wheat shows 5–10% greater yield responses in barley to weed control.

Figure 2. Differences in weed growth under wheat varieties in an SAC Organic Trial, 2001 (EU WECOF Project)



However, there is little published evidence for early September sown wheat yield responses to autumn emerging weeds. Nevertheless, as early sown barley crops are much more subject to weed competition, it is expected that early sown wheat yields will also be adversely affected.

The results of SAC trials suggests that populations of broad-leaved weeds do not have more than about 10% yield effect; however, very high populations of certain weeds can have a bigger impact. HGCA funded work at SAC/ADAS/DANI showed that yield responses to cleaver control can be high in good crops (up to 20% yield benefit from control of 10 cleavers/ m2) and even higher in poor crops.

A pre-requisite for good weed control is good seed used in a good seed-bed, with good nutritional husbandry for good crop vigour.

Key Weeds

The general emergence pattern of broad-leaved weeds and annual meadow-grass is shown in Figure 1. This also includes a 'broken-line' graph for cleavers and other winter weeds such as ivy-leaved speedwell. This Figure, however, hides the pattern of individual species emergence, which is outlined in Table 2 below.

The earlier a crop is sown, the more of the autumn weeds are found and the later it is sown, the more spring weeds are present. Later spring weeds are less of a problem because crops are usually shading enough by then to suppress them. However, thistles and volunteer potatoes can emerge and grow through the crop canopy and present late competition and a long-term weed control problem.

Table 3 below gives the relative competitiveness/ tolerance ranking in terms of yield of wheat of key broad-leaved weeds and meadow-grasses weeds (based on Blair, Cussans & Lutman, 1999, as modified by BASF plc in 'Autumn Weed Management in Cereals: User Guide'). Cleavers is the most competitive of these weeds, and 1 cleaver / m2 is sufficient to reduce yield by 5%. In some cases, e.g. fat-hen, as a spring germinator, the numbers indicated are only occasionally found in later sown wheat crops.

Note that weed control is not just undertaken for yield benefit, but harvest benefits and long-term/ rotational weed seedbank control. Leaving weeds such as chickweed can have severe effects on the crop quality and harvest in a wet season. Other weeds such as knot-grass can reduce the efficiency of combining. Grain contamination with weed seed is a serious problem and can be expensive to clean, if it is possible. Some weeds are not very competitive and die-out before harvest, such as speedwells and deadnettles. However, these and other weeds may be important elsewhere in the rotation, and cereal crops are sometimes used as cleaning crops for the weed seedbank. If the weed is not listed, there is no readily available scientific evidence for the level of competitiveness in wheat.

Rough meadow-grass is not on the list and observations suggest that quite low numbers will affect yield.

Table 2. Pattern of weed emergence by species

Early Autumn	Late Autumn	Early Spring	Late Spring
Annual meadow-grass	Annual meadow-grass	Annual meadow-grass	Black-bindweed
Bugloss/Amsinckia	Cleavers	Cleavers	Charlock
Charlock	Ivy-leaved speedwell	Ivy-leaved speedwell	Fat-hen
Chickweed	Deadnettles	Chickweed	Redshank
Corn marigold	Field pansy	Corn marigold	Thistles
Common-fields speedwell		Common-field speedwell	Volunteer potato
Field pansy		Hemp-nettle	
Forget-me-not		Knot-grass	
Fumitory		Mayweed	
Mayweed		Poppy	
Poppy		Black-bindweed	
Volunteer crops			

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Table 3. Relative competitiveness of weeds in wheat (thresholds giving 5% yield loss)

No Threshold	Up to 20plants/m^2	20-49 plants/m^2	50-99 plants/m^2	More than 100 plants/m^2
Cleavers	Charlock Scented mayweed Oilseed rape Poppy Thistle	Chickweed Fat-hen Forget-me-not Redshank	Annual meadow-grass Crane's-bill Fool's Parsley Fumitory Groundsel Knot-grass Red dead-nettle Sow-thistle Speedwells	Black bindweed Field pansy Parsley-piert

Timing of Weed Control

As suggested above, *early sowing* demands autumn weed control. Some later and spring germinating weeds can still be a problem, particularly in more open wheat crops. Residual herbicides used in the autumn can give persistence to control winter and spring germinating weeds if there is sufficient spring crop competition. However, recent information is suggesting that the persistence of residual herbicides applied in the autumn may have reduced in recent mild, wet winters.

With *mid-autumn* (up to mid-October) sowings it may be worth waiting to see when weeds do emerge, which will vary with season. In a mild autumn weeds do emerge, and where meadow-grass is a problem an autumn treatment is more cost-effective. Where cultivations are used, only use if weeds with tap-roots such as volunteer rape are a problem and if ground conditions are suitable. Cultivations in the autumn are also likely to release and reduce nitrogen reserves in the top-soil.

Late sown crops can usually wait until the spring for treatment, controlling the autumn/ winter emerging weeds along with those that emerge in the early spring. If a lot of grass weeds emerge in a very mild winter, treatments may be applied during breaks in the weather, but do not use cultivators for weed control in the winter.

The Impact of Method of Crop Establishment

The method of crop establishment has a major influence on weed development. Minimal or reduced cultivations are of increasing interest, and most broad-leaved weeds show reduced emergence compared with conventional ploughing. However, major exceptions include volunteer crops from the previous season, groundsel, mayweeds plus most grasses, which tend to increase, and cleaver, which appear relatively unaffected by cultivation.

A stale seedbed approach after cultivation and before sowing, allowing 'greening' of the seedbed which is killed with glyphosate or light cultivation, will reduce such weed problems. However, there is seldom time in northern areas to do this before winter barley or early wheat is sown, and these weeds plus other grass weeds can be difficult to control in such situations. Where such weed problems occur, consider delayed-sown wheat as the preferred option.

Many broad-leaved weed populations are reduced by the use of grass leys in the rotation. A 2-3 year grass ley in the rotation can reduce weed seed burdens by up to 50% in the following crop after ploughing, and the use of grassy set-aside can be an alternative to grass rotations.

Charlock

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Biodiversity Benefits of Weeds

- Leaving certain weeds has biodiversity benefits and if game is of importance, can help game management. Birds and small mammals take the seed of weeds and the insects living on the weeds. The weeds can also be a haven for natural predators of insect pests – boosting their control.
- Knot-grass, redshank, black-bindweed, mayweeds and chickweed are amongst the most valuable weeds for birds.
- Consider using Game Conservancy guidelines for headland management to allow for conservation of these weeds. In particular avoid use of herbicides except for amidosulfuron for cleavers and grass weed herbicides.
- There is an agri-environment scheme available for such headlands – talk to your local SAC or FWAG advisor

Types of Herbicide Activity

Cereal herbicides can be categorised into these main types:

Residual Herbicides

(a) Residual herbicides that can only be used before crop and weed emergence is now limited to terbutyne (which will not be sold after July 2003 and cannot be used after December 2003 and does not otherwise appear in this TN) and a new trifluralin and linuron mixture, and those with more flexibility in crop timing, but only have good activity pre-emergence of weeds, notable trifularalin.

(b) Those that can be used pre- or post-emergence of the crop and have some post-emergence activity on the weeds, e.g. diflufenican, pendimethalin, but may need the addition of a contract herbicide if the weeds get larger than about two leaves.

(c) Those that can act on larger weeds and have some residual activity, e.g. isoproturon, flupyrsulfuron.

Contact Herbicide

Contact herbicides kill weeds by purely foliar uptake and scorch is the usual symptom, e.g. bromoxynil, ioxynil, carfentrazone. Broad-leaved weeds are best controlled when small.

Translocated Herbicides

These work through foliar uptake and movement through the plant tissues. Symptoms are often slow to appear, especially in cold weather. They include hormonal, or hormone-type herbicides, e.g. mecoprop-p, dicamba, fluroxypyr, which cause foliar distortions in the weeds, sulfonyl-ureas and related products which stop plant growth before plant chlorosis/necrosis establishes.

Herbicide Treatments in the Autumn

Herbicide treatments in the autumn are generally based on a residual herbicide to keep the crop weed free until at least the end of winter, and in later sown crops this may mean that some spring weed control is also possible. However, in early sown crops, particularly more open wheat crops, a follow-up spring treatment may be needed, particularly for later emerging weeds such as cleavers.

Some products can be used pre-emergence of the crop and weeds. If the broad-leaved weeds present have more than a couple of leaves, a foliar acting herbicide may have to be added to improve control of most products. Some products contain a residual herbicide plus a foliar acting treatment or at least a residual that will take larger weeds, such as isoproturon or picolinafen. Isoproturon is usually used where grass weeds are a problem. Otherwise for larger broad-leaved weeds, mecoprop-p, flupyrsulfuron and tribenuron are the most common foliar acting additions in the autumn.

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Herbicide Treatments in the Winter

In general, conditions are not suitable for treatments in the winter. It is preferable to wait until conditions improve in early spring. Nevertheless, in a mild autumn weeds may emerge in later sown crops, and if a lot of meadow-grass emerges it is more cost-effective to treat it when small. Residual products including isoproturon and pendimethalin can be used to kill small meadow-grass, and give weed control into the spring. However, do not use herbicides on water-logged land or stressed crops to reduce crop damage and isoproturon leaching problems.

Herbicide Treatments in the Spring

Herbicide treatments in the spring have two main aims: in late sown crops it may be the key weed control timing. In earlier sown crops, they may be used as a follow-up treatment if weeds have escaped early control.

In general, spring broad-leaved weed control products tend to be largely foliar acting, although some residuals, e.g. diflufenican, pendimethalin, can be used up to first-node stage of the crop. Broad-spectrum spring herbicide treatments are used when you are sure most weeds have emerged, and most commonly contain a sulfonyl-urea, such as metsulfuron, thifensulfuron, plus a hormone, e.g. mecoprop-p, and/or a contact herbicide, e.g. bromoxynil/ioxynil, carfentrazone. Where cleavers are a problem a range of other products may be used (see Cleavers box).

If annual meadow-grass is present, flupyrsulfuron, chlorotoluron or isoproturon may be added to the spring treatment, but well tillered annual meadow-grasses may not be fully controlled. Rough meadow-grass will need another treatment for good control, such as clodinafop-propargyl, tralkoxydim or fenoxaprop-p-ethyl in wheat, tralkoxydim in barley, and chlorotoluron in certain varieties of both. Iodosulfuron is a new wheat herbicide which may check meadow-grasses.

Where using sequential treatments or mixtures of herbicides, check the label whether such sequences/mixtures are allowed. In particular, sulfonyl-ureas (-sulfuron herbicides) and related ALS-inhibitors such as florasulam and propoxycarbazone-sodium have many such restrictions, but this does apply to other herbicides. Many broad-leaved weed herbicides have to be used in sequence rather than mixed with wild-oat/ black-grass/ rough meadow-grass herbicides; read the label carefully before use.

Pre-harvest Treatments

Where earlier treatments have failed, glyphosate can be used in cereal crops to desiccate weeds as well as green stems (harvest-aid). It can also help to control perennial weeds, if they still have green foliage, such as couch-grasses, thistles, docks and volunteer potatoes. Use when the grain has 30% moisture or less. Do NOT use on seed crops. If the crop is being used for malting, confirm the treatment is acceptable with the merchant.

Warning Notes on Herbicides

- Take care in mixing or sequencing herbicide treatments, and mixing with other pesticides or nutrients. Follow the label instructions.
- Avoid treatment in waterlogged or frosty conditions, or if the crop is suffering from nutrient stress.
- Note that some residual herbicides work poorly in soils of high organic matter content (5–10% or more).
- Spray-drift of cereal herbicides can seriously damage other crops, field boundary vegetation, etc. Do not spray in windy conditions and wait until any air movement is away from sensitive crops.
- Clean out sprayers thoroughly immediately after use. This is expecially important when moving from one crop to another. Follow the manufacturers' instructions fully regarding washing procedures.
- If spraying near surface water, note whether LERAP restrictions apply to the treatment and change practice or treatment accordingly.

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Herbicide Resistance

- Resistance to sulfonyl-urea herbicide (e.g. metsulfuron, tribenuron, etc.) has been found in a few populations of chickweed in Scotland and chickweed and poppies in England, and cross resistance to florasulam in a Scottish population.
- Do not rely on single herbicide groups for your broad-leaved weed control. Mix herbicides from different groups whenever possible. If mixtures can not be used, use sequences of herbicides from different groups.
- Rotate herbicide product use wherever possible, and particularly where continuous cereal cropping is common. In particular, in winter cereals, use an autumn residual as an alternative to relying completely on spring herbicide treatments.
- The Weed Resistance Action Group (WRAG) produce an excellent guidelines leaflet on weed resistance and management strategies: 'Managing and preventing herbicide resistance in weeds 2003'. Published by the Home Grown Cereals Authority (HGCA), London (E-mail: research@hgca.com).

Control of Cleavers

- A range of herbicide products can be used in the spring for control of cleavers.

(a) Amidosolfuron, from 1st February, GS12-49 of the crop, up to flowering of cleavers, but best up to GS32 of the crop.

(b) Amidosulfuron + iodosulfuron. From 1st February, GS12-51 of the crop, up to flowering of cleavers, but best up to GS32 of the crop. Straight iodosulfuron will be available from 2003 which controls cleavers to 8 whorls.

(c) Cinidon-ethyl + mecoprop-p, GS12 – before GS33 of the crop, up to 30cm length cleavers.

(d) Florasulam, from 1st February, GS13 up to flag-leaf G39 of the crop, up to 50cm cleavers.

(e) Florsulam + fluroxypyr, from 1st March, GS13 – up to flag-leaf GS39 of the crop, up to flowering of cleavers.

(f) Fluroxypyr, GS12-GS45 inclusive of the crop, up to flowering of cleavers.

- Trials at SAC and ADAS show that the use of a residual herbicide based on diflufenican or pendimethalin in the autumn improves the activity of fluroxypyr and other herbicides in the spring on cleavers.
- Cleaver herbicides control other weeds (Tables 5/6) and can form part of a general weed control programme.
- Trials at SAC and ADAS show that cleaver control can be delayed to around crop stage GS30-31 without affecting yield, and allowing treatment when weather conditions have improved in the spring.
- Amidosolfuron (especially plus iodosulfuron), cinidon-ethyl and florasulam work better in colder conditions than fluroxypyr, but fluroxypyr may be move active on large cleavers in warm, dry conditions.

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Control of Creeping Thistle

- This is becoming a more common weed in winter wheat. It emerges after herbicides are usually applied.
- Sulfonyl-urea herbicides are effective; notably metsulfuron, which can be used up to crop flag-leaf emerging (GS39).
- Hormonal herbicides 2,4-D and MCPA, can be used but only up to GS30 of the crop. Clopyralid is effective, but only up to GS31 of the crop.
- Use pre-harvest glyphosate only if the thistles are still green and growing, otherwise the activity on the weed rhizomes will be reduced.

Volunteer Potatoes

- Sulfonyl-ureas, especially metsulfuron + thifensulfuron, kill potato true seedlings and supress growth of plants from groundkeeper tubers, used up to GS39 of the crop.
- Fluroxypyr stunts growth of volunteers and reduces tuber development and vigour, used up to GS45 of the crop. Tank mixtures with metsulfuron + thifensulfuron improve control of tubers.
- Pre-harvest or post-harvest use of glyphosate is effective at reducing tuber survival and regrowth, but only if the potato plants are still actively growing at time of treatment.

Herbicide Doses

- Product labels give the manufacturers' recommended doses for robust control, as well as the maximum doses allowed.
- Some flexibility with doses may be possible with some products. However, this depends on the product and the weed.
- Use of doses below those recommended are entirely at the user's risk. However, some reductions may be possible if growing conditions are good, soils moisture is adequate and the crops are highly competitive and vigorous. This should be discussed with your advisor/distributor, who may have more information on such approaches.

Table 4. Candidate winter cereal herbicides with mainly pre-emergence activity on common broad-leaved weeds and annual meadow-grass in the autumn

Active Ingredient	Amsinckia/ Bugloss	Charlock	Cleavers	Chickweed, common	Corn Marigold	Crane's-bills	Deadnettles	Field Bean, volunteer	Fool's-parsley	Forget-me-nots	Fumitory, common	Gromwell, field	Groundsel	Linseed, volunteer	Mayweeds	Nipplewort	Oilseed rape, volunteer	Pansy, field	Parsley-piert	Poppy, common	Runch/ Wid Radish	Shepherd's-purse	Speedwell, common field	Speedwell, ivy-leaved	Spurrey, corn	Annual meadow-grass	Maximum Weed Size
DFF + trifluralin	–	–	(S)	S	–	–	S	–	–	S	M	–	–	–	M	–	M	S	S	S	S	S	S	S	–	(S)	2 lf; ( ) best pre-em.
PDM	–	S	–	–	S*	–	S	–	–	S	M	–	–	–	M*	–	S*	S*	S	S	–	M	S	S	–	S	Best pre-em.
PDM + flufenacet	–	–	M*	S	S	–	S*	–	–	M*	M*	–	–	–	M*	–	S*	M	S*	S*	–	S	S	S	–	S	2 lf, but best pre-em.
Trifluralin	–	–	–	S	–	–	M	–	–	S	M	–	–	–	S	–	–	–	–	M	–	–	S	S	M	S	Pre-em.
DFF= diflufenican; PDM= pendimethalin; * higher dose required; M= moderately susceptible; S= susceptible; – no information or resistant.																											

Table 5. Candidate winter cereal herbicides with pre-emergence and early post-emergence activity on common broad-leaved weeds and annual meadow-grass in the autumn

Active Ingredient	Amsinckia/ Bugloss	Charlock	Cleavers	Chickweed, common	Corn Marigold	Crane's-bills	Deadnettles	Field Bean, volunteer	Fool's-parsley	Forget-me-nots	Fumitory, common	Gromwell, field	Groundsel	Linseed, volunteer	Mayweeds	Nipplewort	Oilseed rape, volunteer	Pansy, field	Parsley-piert	Poppy, common	Runch/ Wid Radish	Shepherd's-purse	Speedwell, common field	Speedwell, ivy-leaved	Spurrey, corn	Annual meadow-grass	Maximum Weed Size
DFF + IPU	–	–	(S)*	S	(S)	S	S	–	–	S	–	–	S	–	S	–	(S)	S	S	S	S	S	S	S	–	S	2-6 lf; ( ) best pre-em.
DFF+IPU+ flurtamone	–	S	M*	S	–	–	S	–	–	S	(S)	–	–	–	S	–	S	S	S	S	–	S	S	S	–	S	4-6 lf; ( ) best pre-em.
DFF+ flurtamone	–	–	M	S	–	(S)	S	–	–	S	–	–	–	–	S	–	(S)	S	S	(S)	–	S	S	S	(S)	M	2-4 lf; ( ) best pre-em.
PDM+IPU	–	S	–	S	M*	(S)	(S)	–	–	S	S	–	(M)	–	S	–	S	(S)	S	S	–	S	S	S	(S)	S	To 2-4 lf; ( ) best pre-em.
PDM+ picolinafen	–	–	S	–	–	S	S	–	–	–	S	–	–	–	–	–	S	S	–	S	–	S	S	S	–	(S)	4-6 lf; ( ) best pre- 2 lf.
IPU	–	S	–	S	S	–	–	–	–	–	–	–	S	–	S	–	–	–	S	S	–	S	–	–	S	(S)	To 5 cm ; ( ) early tillers

DFF= diflufenican; PDM= pendimethalin; IPU= isoproturon; * higher dose required. DFF+IPU as in Panther, PDM+IPU as in Encore.; M= moderately susceptible; S= susceptible; – no information or resistant.

Table 6. Candidate winter cereal herbicides with mainly or only post-emergence activity on common broad-leaved weeds and annual meadow-grass in the autumn

Active Ingredient	Amsinckia/ Bugloss	Charlock	Cleavers	Chickweed, common	Corn Marigold	Crane's-bills	Deadnettles	Field Bean, volunteer	Fool's-parsley	Forget-me-nots	Fumitory, common	Gromwell, field	Groundsel	Linseed, volunteer	Mayweeds	Nipplewort	Oilseed rape, volunteer	Pansy, field	Parsley-piert	Poppy, common	Runch/ Wid Radish	Shepherd's-purse	Speedwell, common field	Speedwell, ivy-leaved	Spurrey, corn	Annual meadow-grass	Maximum Weed Size
Carfentrazone	–	–	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	(S)	–	–	Up to 20cm. ( ) up to flower
Carfentrazone+ CMPP-P	–	S	S	S	–	(S)	S	S	(S)	–	(S)	–	–	–	–	–	S	(M)	(M)	(M)	S	S	S	S	–	–	To 6 lf. Cleavers 35cm; ( ) to 2 lf.
Cinidon	–	(M)	S	–	–	–	S	–	–	–	–	–	(S)	–	–	–	–	–	–	–	–	–	S	M	–	–	4-6 lf; cleavers 2 whorls; ( ) to 2 lf.
Cinidon/ CMPP-P	–	S	S	S	–	–	S	–	–	–	–	–	S	–	(S)	–	S	–	–	–	–	–	S	S	–	–	4-6 lf; cleavers 30 cm; ( ) to 2 lf.
Flupyrsulfuron	–	S	–	S	–	S	S	–	–	–	–	–	S	–	S	–	S	–	–	S	–	S	–	–	–	(M)	Up to 6 lf; (M) 1-2 lf best.
Flupyrsulfuron + carfentr-azone	–	S	S	S	–	S	M	–	–	S	M	–	S	–	S	S	S	–	M	S	S	S	(S)	S	–	(M)	Up to 6 lf; ( ) up to 2 lf; (M) 1-3 lf best.
HBN	–	S	–	(S)	(S)	–	S	–	–	S	S*	–	S	–	S	–	–	–	–	S	S	S	S	S	–	–	Up to 6 lf; ( ) 2-4 lf.
CMPP-P	–	S	S*	S	–	M*	–	–	–	S	M*	–	–	–	–	–	S*	–	–	S	S	S	M*	M*	–	–	2-6 lf.
Tribenuron	M	S	–	S	–	(S)	–	(S)	S	(S)	–	–	S	–	S	–	S	(S)	S	S	–	S	(S)	–	–	–	Up to 6 lf plus; ( ) to 2 lf.

CMPP-P= mecoprop-p; HBN= bromoxynil + ioxynil; * at high dose; M= moderately susceptible; S= susceptible; – no information or resistant.

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Table 7. Candidate winter cereal herbicides with mainly post-emergence activity on common broad-leaved weeds and annual meadow-grass in the spring

Active Ingredient	Amsinckia/ Bugloss	Black-bindweed	Charlock	Cleavers	Chickweed, common	Corn Marigold	Crane's-bills	Deadnettles	Fat-hen	Field Bean, volunteer	Fool's-parsley	Forget-me-nots	Fumitory, common	Groundsel	Hemp-nettle/Daynettle	Knotgrass	Mayweeds	Nipplewort	Oilseed rape, volunteer	Pansy, field	Parsley-piert	Poppy, common	Runch/ Wid Radish	Redsahank/Pale persicaria	Shepherd's-purse	Speedwell, common field	Speedwell, ivy-leaved	Thistles	Annual meadow-grass	Maximum Weed Size
Amido-sulfuron	–	M*	S	S	–	M*	M*	–	–	–	–	S	–	–	–	–	M*	–	S	–	–	–	S	M*	S	–	–	–	–	To flower; M up to 6 lf.
Amido-sulfuron + iodosulfuron	–	s	S	S	S	–	–	–	–	–	–	s	–	–	–	m	S	–	m	–	–	m	S	–	S	m	–	–	–	4 lf- flowerbud m/s up to 6 lf.
Carfetrazone	–	–	–	S	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	s	–	–	Cleavers 20cm; s flowering
Carfentrazone + CMPP-P	–	m	S	S	S	–	s	S	S	S	s	s	s	–	S	–	–	–	S	m	m	m	S	s	S	S	S	–	–	4-6 lf; m/s up to 2 lf; cleavers 35 cm.
Cinidon	–	s	m	S	–	–	–	S	–	–	–	–	–	s	S	–	–	–	–	–	–	–	–	–	S	M	–	–	–	4-6 lf; m/s to 2 lf; cleavers 2 whorls.
Cinidon + CMPP-P	–	s	S	S	S	s	–	S	S	–	–	–	–	S	S	s	–	S	–	–	–	–	–	–	S	S	–	–	–	4-6 lf; s up to 2 lf; cleavers 30cm.
Clopyralid	–	–	–	–	–	s	–	–	–	–	–	–	–	S	–	–	S	–	–	–	–	–	–	–	–	–	–	S	–	4-6lf; s up to 2 lf.
2,4-D	–	m	–	–	–	–	–	–	–	–	–	M	m	–	–	m	–	–	–	–	–	S	S	m	S	–	–	M	–	Before flower; m to seedling.
DFF + HBN	–	s	S	–	S	–	–	S	S	–	–	S	S	–	S	S	S	–	–	S	S	S	S	–	S	S	S	–	–	To 4 lf plus; s to 2 lf.
Dicamba + CMPP-P	–	S	S	S	S	S	S	–	S	–	–	–	S	S	–	S	–	–	–	–	–	m	S	S	S	m	–	M	–	To 6 lf; m to 2 lf.
Dicamba + CMPP-P + MCPA	–	S	S	–	–	–	–	–	S	–	–	–	M	M	M	S	S	M	–	–	–	M	S	S	S	–	–	–	–	To 6 lf.
Florasulam	–	–	–	S	S	–	–	–	–	–	–	–	–	–	–	–	S	–	–	–	–	–	S	S	–	–	–	–	–	10cm-flowerbud; cleavers 50cm.
Florasulam + fluroxypyr	–	–	–	S	S	–	–	–	–	–	–	–	–	–	–	–	S	–	S	–	–	–	–	–	–	–	–	–	–	Up to flowering
Fluroxypyr	–	s	–	S	S	–	–	s	–	–	–	S	S	–	S	s	–	–	–	–	–	–	–	–	–	–	–	–	–	Up to flowering; s 2-6 lf.
Flupyrsulfuron	–	S	S	–	s	–	S	S	–	–	–	S	–	S	–	–	S	–	S	–	–	M	–	–	S	–	–	–	m	To 6 lf; m/s best when seedling
Flupyrsulfuron + metsulfuron	–	S	S	–	S	–	S	M	s	–	S	S	m	S	S	S	S	S	S	S	S	S	S	S	S	S	–	S	s	To 6 lf; m/s 1-3 lf.
Flupyrsulfuron + thifensulfuron	–	–	S	m	S	–	S	S	–	–	–	S	–	S	–	–	S	–	S	m	–	S	–	–	S	M	M	–	m	To 6 lf; m/s 1-3 lf.
HBN	S	S	S	–	S	s	–	S	S	–	–	S	S*	S	–	S	S	–	–	–	–	S	S	S	S	S	S	–	–	To 6 lf; s to 2-4 lf.
Iodosulfuron	–	–	–	S	S	–	–	S	–	–	–	–	–	–	–	–	s	–	–	–	–	–	–	–	–	S	–	–	–	S cleavers 8 whorl, flowerbud others. S young plant
MCPA	–	–	S	–	–	–	–	–	S	–	–	M*	M*	–	M*	–	–	–	–	–	–	M*	S	–	S	–	–	M*	–	2-6 lf.
CMPP-P	–	–	S	s*	S	–	M*	–	S	–	–	–	M*	–	–	–	–	–	s*	–	–	–	S	–	S	M*	M*	–	–	2-6 lf.
Metsulfuron	S	m	S	–	S	–	S	S	s	M	S	s	–	S	S	s	S	S	S	s	S	S	S	S	S	S	–	S	–	To 6 lf plus; m/s to 2 lf.
Metsulfuron+Thifensulfuron	S	S	S	s	S	S	S	S	s	M	S	S	–	S	S	S	S	S	S	S	S	S	S	S	S	S	s	–	–	To 6 lf plus; s to 2 lf.
Thifensulfuron+tribenuron	–	–	S	–	S	s	–	–	S	–	–	–	–	S	–	S	S	s	S	S	S	S	–	S	S	s	–	–	–	To 6 lf; plus; s to 2 lf.
Triasulfuron+HBN	–	S	S	–	S	–	–	S	s	S	S	S	s	s	s	s	S	s	S	–	s	S	S	M	S	s	M	–	–	6 lf flower; s to 2-4 lf.
Tribenuron	M	m	S	–	S	–	s	s	s	–	S	s	–	S	s	S	S	–	S	s	S	S	–	S	S	s	–	S	–	To 6 lf plus; m/s to 2 lf.

DFF= diflufenican; CMPP-P= mecoprop-p; HBN= bromoxynil+ioxynil; * higher dose required; M= moderately susceptible; S= susceptible; – no information or resistant (m/s = smaller weeds)

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Candidate Winter Cereal Herbicide Products

Active ingredient	Produce name(s)	Company	Crop Growth Stages	Comments
Mainly pre-emergence on Weeds				
Diflufenican (DFF)+ trifluralin	Ardent (40:400g/l) LERAP – B	Bayer Cropsciences	Pre→GS21	Up to seedlings of same weeds
Pendimethalin (PDM)	Stomp 400SC (400g/l) LERAP – None	BASF	Pre→GS23	Up to cotyledon s of same weeds
PDM + flufenacet	Crystal/Ice (300:60 g/l)	BASF	Pre→before GS23	Before 31 Dec. Aim for pre-emergence of weeds
Trifluralin (+linuron)	Many products; e.g. Treflan (+linuron= Uranus) LERAP – None	Various (Makhteshim Agan)	Pre-em→GS13 (Pre-em)	As surface treatment only. Aim for pre-emergence of weeds (Pre-emergence only)
Pre-emergence and early post-emergence on weeds				
DFF + isoprotoron (IPU)	Panther, Javelin, Grenadier, Tolkan Turbo, etc (Various ratios) LERAP – B	Bayer Cropscience and others	GS11→GS32	Various products with different concentrations of ingredients. The greater the ratio of IPU, the more it is aimed at grass weed control. Otherwise broad-spectrum up to small weeds.
DFF flurtamone + IPU	Ingot (27:67:400g/l) LERAP – B	Bayer Cropscience	GS11→ before GS32	Broad-spectrum up to small weeds.
DFF + flurtamone	Bacara (100:250g/l) LERAP – B	Bayer Cropscience	GS11→ before GS32	Up to small weeds; moderate control of meadow-grass
PDM + IPU	Encore; Jolt (125:250g/l); Trump (236:236 g/l) LERAP – None	BASF	GSH→ before GS31	Broad-spectrum up to small weeds. Higher ratios of IPU in Trump aimed at more grass weed control.
PDM + picolinafen	PicoPro, etc (320:16 g/l)	BASF	GS11→ before GS30	Broad-spectrum Small weeds.
IPU	Various (mostly 500 g/l) LERAP – None	Various	GS11→GS31	Pre-emergence to small meadow-grass plus some broad-leaved weeds
Mainly post-emergence (foliar acting) on weeds				
Sulfonyl-ureas and other ALS inhibitors				
Amidosulfuron	Eagle, Pursuit (75%wwı), Druid (50%ww) LERAP – None	Bayer Cropscience and others	1 Feb; GS12→GS49	Emerged cleavers up to flowering, and some other broad-leaved weeds. Active in cool conditions

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Active ingredient	Produce name(s)	Company	Crop Growth Stages	Comments
Amidosulfuron +iodosulfuron	Chekker (125+1.25 g/kg)	Bayer CropScience	1 Feb; GS12→51	Emerged range of broad-leaved weeds including cleavers
Florasulam	Boxer (50g/l) LERAP – None	Dow Agrosciences	1 Feb; GS13→GS39	Emerged cleavers up to 50cms, plus some other weeds. NB tank-mix/sequence
Florasulam+ fluroxypyr	Starane XL (2.5+100g/l) LERAP – None	Dow Agrosciences	1 March; GS13→GS31	Emerged cleavers up to flowering, plus chickweed, mayweed. Fluroxypyr is not an ALS inhibitor. NB tank-mix/sequence requirements
Flupyrsulfuron	Lexus 50 DF (50%ww) LERAP – None	Dupont	Post-emergence before GS31	Winter Wheat. Broad-spectrum, including small meadow-grass
Flupyrsulfuron + carfentrazone	Lexus Class (16.7+ 33.3%ww) LERAP – None	Dupont	Post-emergence before GS31	Winter Wheat Broad-spectrum, including small meadow-grass
Flupyrsulfuron + metsulfuron	Lexus x PE (33.3+ 16.7%ww) LERAP – B	Dupont	1 Feb; GS12→GS30	Winter wheat Broad-spectrum, including small meadow-grass
Flupyrsulfuron + thifensulfuron	Lexus Millenium (10+40%ww) LERAP – B	Dupont	GS12→GS30	Winter wheat Broad-spectrum, including small meadow-grass
Iodosulfuron	Hussar (5% ww) LERAP – B	Bayer CropScience	GS13→GS32	Winter wheat. Cleavers plus few others and rye-grasses
Metsulfuron	Ally; Jubilee and other (20%ww) LERAP – B	Dupont and others	1 Feb; GS12 (wheat), GS13 (barley) →GS39	Broad-spectrum on broad-leaved weeds
Metsulfuron+ thifensulfuron	HarmOny M (7:68%w/w DP928 (8.6:42.9% w/w) LERAP – B	Dupont	1 Feb; GS13→ before GS39	Winter wheat Broad-spectrum on broad-leaved weeds
Sulfosulfuron	Monitor (80%ww) LERAP – B	Monsanto	1 Feb. GS13→GS39	Winter Wheat Targeted for grass weeds, but controls cleavers and some other broad-leaved weeds
Thifensulfuron+ tribenuron	Calibre (50+25%ww)	Dupont	1 Feb. GS13→GS39	Broad-spectrum broad-leaved weeds

Active ingredient	Produce name(s)	Company	Crop Growth Stages	Comments
Tribenuron	Quantum 75DF (75%ww) LERAP – None	Dupont	GS13→GS39	Broad-spectrum broad-leaved weeds
MKH6561	Attribut (70%ww) LERAP – B	Bayer Cropscience	1Feb→GS37	Winter wheat targeted for grass weeds, but control cleavers and some other broad-leaved weeds
Hormonal herbicides and related activity				
Clopyralid	Dow Shield (200 g/l) LERAP – B	Dow Agroscience	GS12→GS32	Mayweed, thistles and related weeds
2, 4-D	Various	Various	GS15→GS30	Specific weeds, including thistle
Dicamba + mecoprop-p	Various LERAP – B	Various	GS15→GS30	Broad spectrum on spring weeds
Fluroxypyr	Starane 2/ Hurler/ Tomahawk, etc (200 g/l)	Various	GS12→GS45	Cleavers and some other broad-leaved weeds
MCPA	Various	Various	GS15→GS30	For mixtures; useful on brassica weeds
Mecoprop-p	Various (600 g/l)	Various	GS11→GS31	For mixtures, adding activity on a range of broad-leaved weeds
Other herbicides				
Carfentrazone	Aurora (50% w/w)	FMC	GS12→GS32	For mixtures, adding activity on a range of weeds, including cleavers
Carfentrazone + mecoprop-p*	Platform S (1.5:60% w/w)	Dupont	GS21→GS32	For mixtures, adding activity on a range of weeds, including cleavers *Mecoprop-p is a hormonal herbicide
Cinidon-ethyl	Lotus (200 g/l)	BASF		For cleavers and some other weeds
Bromoxynil + ioxynil	Various	Various	GS12→GS31	For mixtures, adding activity on broad-leaved weeds

Notes:

1. Note carefully that ALS inhibitors have limitations on mixing and sequences with other herbicides of similar activity listed above, plus herbicides including metosulam, Dagger and Pinnacle.

2. The use of ALS inhibitors, especially in mixture and sequences, can effect following crop restrictions. Read the label carefully.

3. Do not sequence/mix broad-leaved weed herbicides with wild-oat/black-grass herbicides without checking the label carefully. Some mixtures are damaging, or reduce herbicide activity.

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