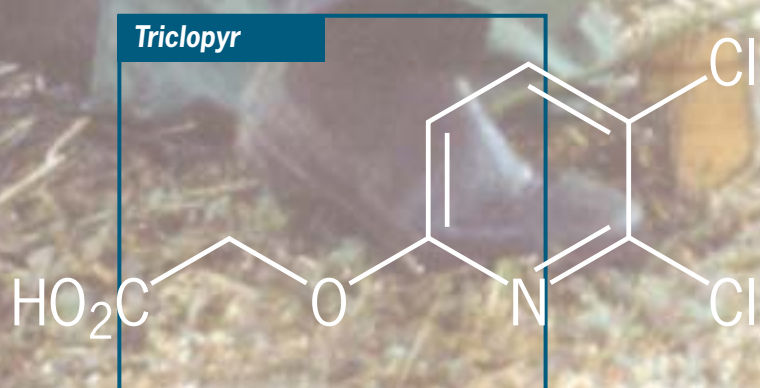
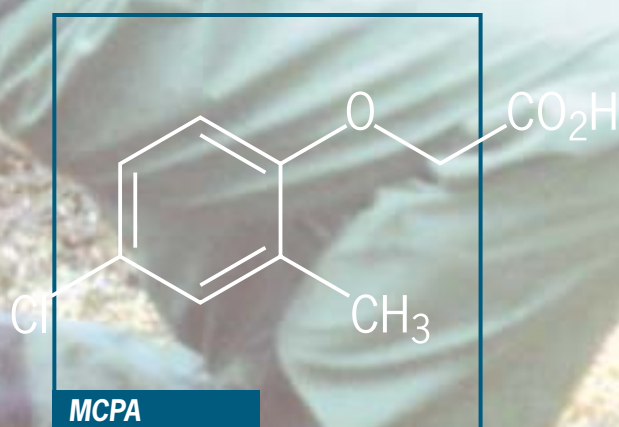
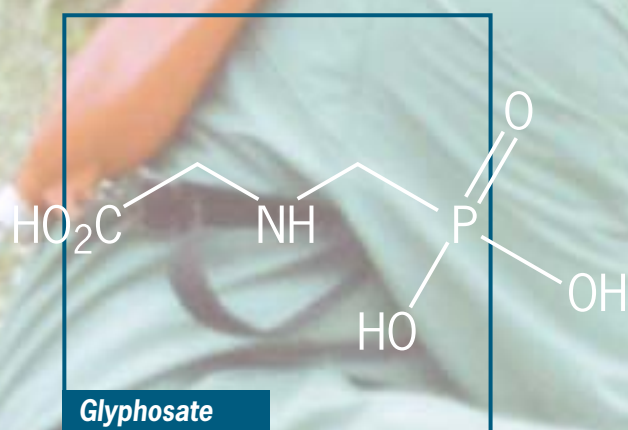
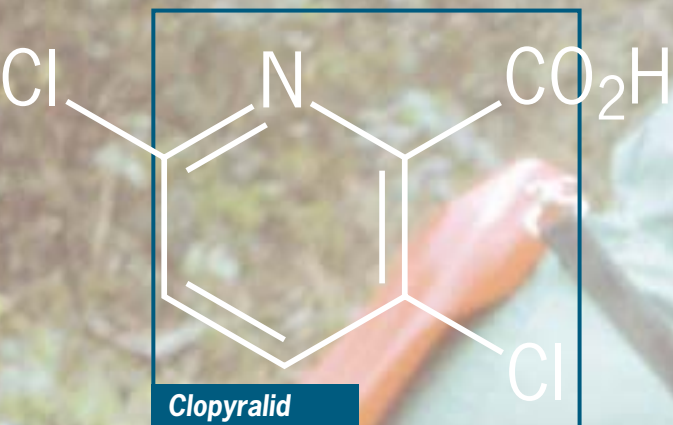


# The Herbicide Handbook:

Guidance on the use of herbicides on nature conservation sites



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# **The Herbicide Handbook:** Guidance on the use of herbicides on nature conservation sites

Based on a report by ADAS under a contract from English Nature Contract No. EIT 31-04-003.

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# Disclaimer

All reasonable efforts have been made to ensure the accuracy of information within this Handbook. English Nature and ADAS cannot, however, be held responsible for any inaccuracies. Neither do English Nature or ADAS accept any responsibility or liability for any damage to the environment or human health, or economic losses that might be alleged to have resulted from any explicit or implied recommendations in this Handbook.

**All those who use pesticides, and those who advise others on pesticide use, have a clear legal responsibility to read and understand the product label (or Notice of Approval for an off-label use) and to fully comply with all the statutory conditions.**

The efficacy/safety information contained within the Herbicide Information Sheets (Section 4.1.3) is intended only as an **indication** of relative species' sensitivities to various herbicides. This information, and other elsewhere in the Handbook, is not necessarily based upon objective, scientific data – and should not be considered as such. Do not assume that a non-target species will be safe from damage just because the relevant herbicide sheet lists it as 'resistant' (*or vice versa*).

Named products are given as examples only. For several of the herbicides described in this Handbook there are numerous approved products that could potentially be used by nature conservation site managers. Not all of these products have been named, but the omission of any product does not imply that it is in any way inferior to those that are named.

Readers must bear in mind that the technical complexity of the subject area, the effects of commercial pressures, and constantly evolving EU and UK legislation mean that much of the detail soon becomes out-of-date. It is expected to make the information in this Handbook available on the English Nature website ([www.english-nature.org.uk](http://www.english-nature.org.uk)) before the end of 2003 and it is hoped that it will then be possible to periodically update the information. It is the responsibility of all pesticide users to ensure that the products used and the methods of storage, preparation, application and disposal are fully compliant with **current** regulations and codes of practice. This cannot and should not be assumed from information in this Handbook or any web version alone.



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**Anyone else?** A sincere thank you to everyone who has helped in any way – and sorry if we have missed you off the list. It has been quite a partnership project and we hope users will find it useful.

Any feedback will be welcomed using the feedback form at the end of the Handbook.





# How to use this Handbook: a few tips for you when considering using herbicides – and this Handbook.

These points jumped out at us during the final editing and preparation of this Handbook for printing. We hope you may find them helpful to peruse; they may appear obvious but can be overlooked:

## Firstly, a few points when considering using herbicides:

- If you have a weed problem take time to consider **why** you have a problem? What management is occurring that is leading to the infestation(s)?
- Take steps to ameliorate the cause(s). Without such action it is likely you will be returning time and time again to re-treat future re-infestations. Most herbicides are not a panacea cure for more than a year or two in conditions which are favourable to re-infestation.
- Re-assess whether you do need to use a herbicide or are there alternative techniques. (This is relevant to Government's Pesticide Minimisation Policy and reducing environmental pollution).
- Assess the various technique options against environmental and resource issues. Look ahead to the knock-on effects and the need for continuing or future action after you have done the current management.
- Preventing a problem is always better than trying to cure it later!
- If you get a 'weed' problem tackle it **early**:
  - a) **early** in the infestation when its population is small. (So long as it **is** going to develop into a real problem?),
  - b) **early** in the season when the weed is more susceptible to treatment and before other herbage gets in the way,
  - c) **early** in the day - applications in the morning are more effective than in the evening (in terms of reducing weed numbers and weight) due mainly to relative humidity.

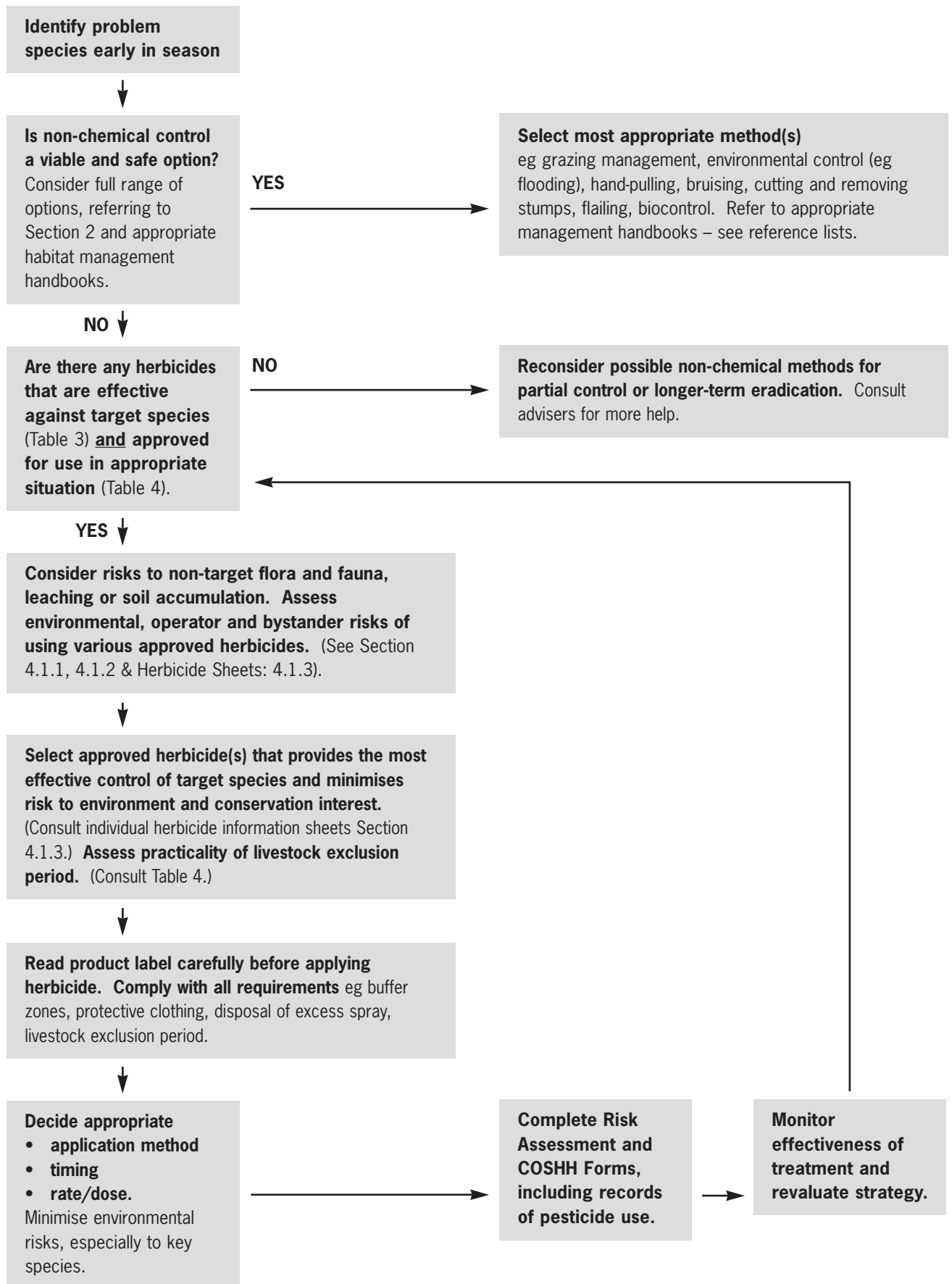
## Secondly, a few suggestions to help you get the best out of this handbook:

The following suggestions are made to ensure you refer to important legal information and then to guide you to the information you require in order for you to make informed decisions as to technique and best herbicide choice for your situation:

- Note the 'decision tree' provided as Figure 1. This leads you through a decision-making process you should find helpful.
- Look at the Summary to get an overview of the information provided in the Handbook.
- Scan through the Handbook to get an overview of the information in each Section.
- Note that **Table 3** is the main source of **summary** information if you are wanting to assess choice of herbicides appropriate to a **specific 'weed'**.
- Note that **Table 4** is the main source of information if you are wanting to find out **summary** information appropriate to how **specific herbicides** may be used.
- Get used to using the chemical/active ingredient (a.i.) name as well as the product name. The listing in Table 4 is by 'a.i.' (eg glyphosate) not the commercial 'approved product' name (eg Roundup Biactive). The product names are in the second column against the active ingredient name to allow cross-referencing.
- For more **information on a chosen herbicide** then turn to **Section 4.1.3** where relevant **detail**, appropriate to conservation managers, is described. This information may be cross-checked and updated against information in the annually produced *The UK Pesticide Guide* (Whitehead 2003). Finally, check the product literature and label.

**The production team wishes you success in managing your 'weeds'.**

**Figure 1. A ‘decision tree’ to help you choose the most appropriate method to control problem species.**



# Summary

## Introduction

1. **Competitive ‘weed’ species.** Vegetation management is an essential part of the overall habitat management strategy on most nature conservation sites. Species of conservation importance are frequently threatened by competitive ‘weed’ species. These commonly include native species such as birch, hawthorn, bracken, docks, ragwort, common nettle, bramble and common cord-grass, as well as invasive alien species like rhododendron, Japanese knotweed, Indian (Himalayan) balsam, giant hogweed and New Zealand pigmyweed (Australian swamp stonecrop). Appendix 1 provides a listing of identified target species.
2. **Early detection.** Site managers should be vigilant, watching out for early signs of possible weed problems. A problem detected in the early stages will be more easily, safely and cheaply dealt with.
3. **Non-chemical control methods.** These should be considered first (see also 7 below). This is in order to comply with the Government’s pesticide minimisation policy set out in *This common inheritance*. Quote: “The amount of pesticides used should be limited to the minimum necessary for the effective control of pests compatible with the protection of human health and the environment” (HMSO 1990).

This is supported by an English Nature policy statement:

“To maximise the contribution of a pesticide policy to achieving government’s targets for farmland biodiversity, pesticide minimisation programmes are required which have this clear objective. A reduction in the impact of pesticides, as a component of wider measures to achieve biodiversity targets, will require the use of more selective products, more targeted applications, and greater use of non-chemical means over wide areas of farmland.” (Burn 2000).

It is accepted that herbicides may frequently form a key component of the selected management programme.

4. **Purpose of the Handbook.** The primary aim of this Handbook is to summarise information on the use of herbicides to control problem species or ‘weeds’ in

nature conservation sites. It updates and replaces the Nature Conservancy Council publication *The use of herbicides on nature reserves* (Cooke 1986) and includes an expanded list of potential herbicides and takes account of several important pieces of legislation that have come into force since its publication.

5. **Uses for the Handbook.** The Handbook is intended as a general guide to herbicide use for nature conservation site managers. It should also provide valuable information for other landowners, managers and contractors responsible for weed control in other semi-natural habitats (such as woodlands, forests; hedgerows, river-banks, streamsides and aquatic areas); field margins and other areas of uncropped farmland; amenity areas; canals; road verges; and railways.

## Use of herbicides – general guidance

6. **Risk assessment.** The use of herbicides should always be preceded by a **risk assessment** that must include consideration of any potential effects on the environment and on human health. Risk assessments should also consider the likely ecological impacts of taking no action.
7. **The Control of Substances Hazardous to Health (COSHH) Regulations 1989.** These require that **pesticides (and herbicides are pesticides) should only be used where necessary** and where the benefits significantly outweigh the risks to human health and the environment. Non-chemical control options must, therefore, be considered and **herbicides should only be used in situations where alternatives do not exist, or are impractical or likely to be inadequate.**
8. **Non-chemical techniques.** The Handbook, therefore, includes a short summary of non-chemical control methods – including grazing and methods of environmental, mechanical and biological control. References to other publications that deal with this subject in much greater depth are provided.
9. **Factors affecting choice.** If a decision is made to use a herbicide, either as the sole method of control or as part of an integrated programme then the most

appropriate chemical and product must be selected. The choice of chemical will depend on a number of factors, but will be particularly influenced by:

- **Approval status.** Which herbicide products (if any) can legally be used against the target species in that particular situation?
- **Efficacy.** Which approved herbicides are likely to be effective against the target species? Which is the most effective option?
- **Environmental safety.** What are the likely direct and indirect effects on non-target species? How do the possible alternative herbicides compare?

10. **Approvals.** Only pesticides approved under the Control of Pesticides Regulations 1986 (COPR) as amended by the *Control of Pesticides (Amendment) Regulation 1997* - or, for products containing more recently available active ingredients, the *Plant Protection Products Regulations 1995* (as amended) (PPPR) (Anon 1995) and the *Plant Protection Products (Basic Conditions) Regulations 1997* - can legally be sold, supplied, stored, advertised or used. **Current lists of approved products can be found on the Pesticide Safety Directorate (PSD) website at [www.pesticides.gov.uk](http://www.pesticides.gov.uk).** All pesticides must also have an appropriate full or 'off-label' approval for use in a relevant situation.

11. **Offences. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use** (including where the crop or situation is the subject of an off-label extension of use). **ALWAYS READ THE PRODUCT LABEL BEFORE USING A PESTICIDE AND COMPLY WITH ALL STATUTORY CONDITIONS.**

12. **Off-label use.** Where a pesticide is to be applied under the terms of an off-label approval, users must obtain and read the relevant Notice of Approval (published by Defra). Lists of specific off-label approvals and the relevant notice of Approval can be found on the PSD website. Users should be aware that there is a risk that pesticides used under an 'off-label' approval may not be as effective. Users must comply with all statutory conditions for approved uses of that product described on the label.

13. **Adjuvants.** Adjuvants are substances that enhance the effectiveness of a pesticide, eg extenders or wetting agents. Although adjuvants are not classed as pesticides, pesticide legislation still stipulates that only authorised adjuvants may be used with pesticides.

14. **Tank mixes.** Users must comply with the individual conditions of approval for all pesticides concerned when making up tank mixes of two or more pesticides.

15. **Protection of water.** FEPA places a special obligation on all pesticide users to prevent pollution of water. No pesticides may be used in or near water, unless the approval specifically allows such use. The Environment Agency (or SEPA in Scotland) must always be consulted before any application of herbicides in the vicinity of an area of water, water courses and areas of water abstraction.

16. **Herbicides approved for use in or near water.** Those that might be useful to nature conservation site managers include certain products containing 2,4-D, dichlobenil, glyphosate and terbutryn (up until December 2003 only). Additionally, fosamine-ammonium and maleic hydrazide are approved for use near water. Two diquat products, *Midstream* and *Reglone*, were also approved for use in areas of water, but a recent EC review has resulted in the revocation of all approvals for the use of diquat in aquatic situations. This, and the impending withdrawal of terbutryn, will make the control of many aquatic weeds much more difficult. For example, diquat was the recommended treatment for major infestations of Australian swamp stonecrop – a major problem in many areas.

17. **Buffer zones.** Herbicides considered to have the greatest potential to harm aquatic species have a legally binding requirement for an unsprayed buffer strip between the sprayed area and any watercourse (or the top of a river or streambank). Minimum distances may be reduced if a properly documented Local Environment Risk Assessment for Pesticides (LERAP) concludes that the risks of water pollution are low, eg because of the use of reduced doses, low drift spray nozzles or weed wipe.

18. **Methods of application.** Efficacy and environmental safety are directly affected by the method of application, which must comply with statutory requirements (eg product label for *Fusilade 250 EW* forbids applications via hand-held, CDA or aerial sprayers).

19. **Effective targeting of herbicides.** This is important, particularly when non-selective herbicides are used. Non-selective herbicides such as glyphosate and imazapyr present the highest risk to non-target plants. The method used to apply a herbicide will be influenced by:

- approved conditions of use as described on the label,
- the extent and distribution of target species,

- height and structure of target species,
- height, structure and sensitivity of surrounding/ adjacent non-target species,
- the nature of the local terrain, eg presence of streams, hillsides.

20. **Applicators.** The most widely used type of hand-held sprayer is the knapsack sprayer, which is suitable for spot-treatment of weeds, spray applications on very rough or steep terrain, basal bark sprays and cut stump treatments. Sprayers mounted on tractors or ATVs are more suitable for larger areas of relatively even ground, in areas of low vegetation, eg grassland.

Granular herbicides (eg *Kerb Granules* and *Casoron G*) can be applied using either hand-held 'pepperpot' or larger tractor- or ATV-mounted applicators.

Weed-wipers provide a method for the targeted treatment of weeds that are taller (at least 10 cm taller) than the associated non-target vegetation; for example bracken, thistles or common ragwort in grassland (marsh ragwort in damp meadows can be at the same height as other vegetation or even below it). Weed-wipers are also available for different scales of operation – from small hand-held wipers to large tractor-mounted equipment.

Injection of translocated (systemic) herbicides may be directly into the stems of target trees or shrubs, virtually eliminating any risk to non-target plants. 'Injection' might simply involve spraying small quantities of herbicide into a 'frill' cut with a hatchet.

Paintbrush application to cut stems of woody plants with a concentrated solution of a translocated herbicide may be acceptable unless the product label precludes it.

21. **Timing of application.** The time of year that a herbicide is applied might be constrained by legal requirements stipulated in the approval or described on the product label. Users should take this into account as well as whether the herbicide will be effective against the target species (many herbicides are more effective when applied to actively growing weeds) **and** any probable impacts of different timings on other non-target species on that site.

22. **Training and certification of advisers and spray operators.** Anyone who gives advice when selling or supplying agricultural pesticides must have a BASIS Certificate of Competence.

Anyone applying agricultural pesticides to land not owned or occupied by them or their employer, must also hold a recognised Certificate of Competence (unless born before 1965 or working under the direct supervision of a certificate holder).

23. **Health and safety.** All herbicides are potentially dangerous. A risk assessment must be carried out before herbicide applications, to assess any risks to operators and the general public. A COSHH form should be filled out for all chemicals used. Any protective clothing that is required for the handling and use of the pesticide will be stipulated on the product label and must be worn. Information relating to first aid and medical treatment in the event of accidental exposure to the chemical is also given on the product label.

24. **Environmental safety.** An evaluation of environmental risks – essential wherever pesticides are used – is particularly important on nature conservation sites. This evaluation should always consider both short and long-term effects, remote as well as local effects, impacts on animals as well as plants and possible indirect effects, eg through destruction of nesting sites, deoxygenation of ponds caused by organisms decomposing, dead vegetation. A detailed assessment of the possible impacts on species of local conservation interest will be essential.

To minimise the effects of herbicides on non-target species:

- Use a selective herbicide that is less damaging to non-target species.
- Leave an unsprayed buffer zone between treated area and vulnerable species/habitats.
- Avoid spraying in unsuitable weather conditions, eg when wind speed is greater than force 2 (7-11 km per hour) on the Beaufort Scale or on very calm, warm days when volatilisation can occur.
- Avoid fine sprays - use medium-coarse droplet nozzles.
- Keep spray nozzles as close as possible to target plants (taking account of minimum nozzle height).
- Spot-treat, if possible, and use a guard on the sprayer lance to more effectively target sprays and reduce drift.
- Ensure that any unused pesticide and any empty containers are disposed of safely (see *Code of practice for the safe use of pesticides on farms and holdings* - the 'Green Code').

## Approved herbicides

25. **Pesticide approvals system.** Only approved herbicides may legally be used. A herbicide must also have a full or off-label approval for use in the situation in which it is to be applied.

Since January 2001 all new product approvals are authorised for use in one or more categories within the PSD 'Crop Hierarchy'. The 'primary groups' most relevant to nature conservation sites are **agricultural herbage, forestry, aquatic area and industrial and amenity areas**. The most relevant 'basic crops or situations' within these four primary groups are:

• Agricultural herbage	permanent grassland
• Forestry	forest, farm forestry
• Aquatic area	enclosed waters, intertidal zones of estuary, land immediately adjacent to aquatic area, open waters
• Industrial and amenity areas	amenity grassland, amenity vegetation

Areas of unimproved or semi-natural grassland may be classed either as **permanent grassland** (if grazed) or **amenity grassland** (if not grazed). The position regarding heathland habitats is less well defined. Heathland or moorland that can be grazed could be classed as **permanent grassland**. Grass-dominated heathland that is not grazed might be considered **amenity grassland**, whilst areas with a smaller grass component would be **amenity vegetation**. **Amenity vegetation** is defined as "Any areas of semi-natural or ornamental vegetation, including trees... includes areas of grassland... and areas to which the public have access. Does not include hedgerows around arable fields." Mature hedgerows around arable fields are included in the definition of **farm forestry**.

26. **Target species and possible herbicides for their control.** Table 3 (Section 4.1.2) of this Handbook includes a listing including only those herbicides with approvals for use in situations considered relevant to nature conservation sites. This table includes short notes on relevant situations, application methods and timings for each listed herbicide.

27. **Key herbicides for use in nature conservation sites.** Table 4 (Section 4.1.2) of this Handbook also includes a total of 38 herbicides and mixtures which are listed along with the names of most of the products with relevant current approvals. This table lists the manufacturer/distributor and formulation by concentration of active ingredient (a.i. conc.) for each listed product. The table also includes notes on the target plants/plant groups for which it is recommended, the relevant approved uses and the stock withholding period.

28. **Herbicide Information Sheets.** In Section 4.1.3 detailed information is provided on 26 herbicides. These include information on application scenarios, fate in soil and water, effects on terrestrial and aquatic fauna, and effects on non-target plants. The herbicides covered are:

Ammonium sulphamate\*  
Asulam  
Clopyralid  
Cycloxydim  
2,4-D  
Dicamba  
Dichlobenil\*  
Dichlorprop  
Diquat\*  
Ethofumesate  
Fluazifop-P-butyl  
Fluroxypyr  
Fosamine-ammonium  
Glufosinate-ammonium\*  
Glyphosate\*  
Imazapyr\*  
Maleic hydrazide  
MCPA  
MCPB  
Mecoprop-P  
Mefluidide  
Paraquat\*  
Picloram  
Propyzamide  
Terbutryn  
Triclopyr

\*Ammonium sulphamate, dichlobenil, diquat, glufosinate-ammonium, glyphosate, imazapyr and paraquat are **non-selective**, post-emergent herbicides – active against most plant species. **Consequently, particular care must be taken to avoid (or minimise) any contact with non-target species (eg via spray or vapour drift).**



Herbicides with **more selectivity** include asulam (toxic to most fern and bryophyte species, but also toxic to several other species, including grasses and dicotyledons), clopyralid (daisy and pea families), cycloxydim (most grasses), 2,4-D (dicotyledons), dicamba (dicotyledons), dichlorprop (dicotyledons), ethofumesate (annual grasses and some dicotyledons), fluazifop-P-butyl (most grasses), fluroxypyr (most dicotyledons), fosamine-ammonium (woody plants, bracken), MCPA (most dicotyledons), MCPB (most dicotyledons), mecoprop-P (most dicotyledons), picloram (bracken and dicotyledons), propyzamide (grasses and some dicotyledons), terbutryn (most aquatic weeds, including algae), triclopyr (woody plants and most other dicotyledons).

29. **Plant growth inhibitors.** Maleic hydrazide and mefluidide are plant growth inhibitors used to retard the growth of grass. Maleic hydrazide is also approved for the inhibition of growth in hedges and tree suckers.
30. **Other herbicides.** In **Section 5** less detailed information is provided on a small number of additional herbicides that have an approval status that would allow their use in some situations on nature conservation sites, along with others that have no current approvals but which could provide useful options at some future date. These additional herbicides that could be useful to site managers in particular situations include amidosulfuron (as *Squire*), amitrole (as *Weedazol-TL*), citronella oil (as *Barrier H*), propaquizafop (as *Falcon*) and quinmerac + metazachlor (as *Katamaran*).
31. **Herbicides for problematic species.** **Appendix 2** lists other herbicides that have been shown by researchers to have useful efficacy against various problematic species. Some of these herbicides have no current relevant approvals for nature conservation sites.

## Effects on non-target species

32. **Direct effects on non-target species.** Direct effects of herbicides are mainly restricted to plants, with most, posing little or no direct risk to invertebrates or other animal groups. The main exceptions are the triazine herbicides (atrazine, cyanazine, simazine, etc) which can be moderately toxic to soil-dwelling invertebrates.

33. **Indirect effects on non-target species.** More significant are the indirect effects of herbicides on animals, which must also be considered as part of the necessary risk assessment process. Invertebrates can be affected by the removal of food plants or destruction of vegetative cover (particularly important for over-winter survival). Birds and mammals can be affected by reduced availability of food plants (foliage, seeds, fruits) and animal prey, and loss of nesting habitat.

34. **Knock-on effects on flora and fauna.** The selective removal of certain plant species will also result in changes to the floral composition, over and above those resulting directly from the effects of the herbicide. Eliminating, inhibiting or reducing the population of one (or a group of) species will indirectly result in enhanced competitive ability in other species. The species that subsequently do well, as a result of removal of competitors or an altered microclimate, will not always be desirable species – so the likely ecological consequences of herbicide use (or other vegetation management operations) must be carefully thought through by the nature conservation site manager before treatment commences.



# 1. Introduction

## 1.1 Vegetation management on conservation sites

Vegetation management generally forms part of the overall habitat management strategy on most nature conservation sites. Frequently, the protected species on these sites may be threatened by other, less desirable, species that must be controlled. Problem plants may include native species such as birch *Betula* spp., hawthorn, bracken, common ragwort, creeping thistle, bramble and common nettle, or invasive aliens such as *Rhododendron ponticum*, Japanese knotweed, Indian balsam, giant hogweed, Sitka spruce, sycamore, water fern, Canadian waterweed and New Zealand pigmyweed (Australian swamp stonecrop).

Initial consultations with nature conservation site managers, conservation advisers, ecologists, researchers and weed control specialists produced a list of 85 plant species that present problems as 'weeds' on conservation sites. This list is shown in Appendix 1. Although extensive and representative of many different habitats, it is not comprehensive. There will undoubtedly be other species that occasionally require control.



Rhododendron on Duddon Mosses NNR. Paul Glendell/English Nature

Control of problem species should first be addressed by improved habitat management to remove the cause of infestation. For example this may require changes to pasture management by changes to the grazing regime to minimise establishment opportunities. Thereafter various techniques including pulling, levering, bruising, cutting or mowing may remove or weaken plants and prevent them seeding.

All nature conservation site managers, like other land managers, have an obligation to firstly consider non-chemical methods of 'weed' control. This is in order to comply with the Government's pesticide minimisation policy set out in *This common inheritance* (HMSO 1990): "The amount of pesticides used should be limited to the minimum necessary for the effective control of pests compatible with the protection of human health and the environment."

This is supported by an English Nature policy statement:

"To maximise the contribution of a pesticide policy to achieving Government's targets for farmland biodiversity, pesticide minimisation programmes are required which have this clear objective. A reduction in the impact of pesticides, as a component of wider measures to achieve biodiversity targets, will require the use of more selective products, more targeted applications, and greater use of non-chemical means over wide areas of farmland" (Burn 2000).

However, herbicides may offer an alternative and it is accepted that herbicides may frequently form a key component of the selected management programme. There may be situations in which the use of herbicides is considered essential – either alone, or as part of an integrated approach, involving both chemical and non-chemical methods.

One important rule for nature conservation site managers is to remain vigilant for 'problem' plant species. A problem that is identified early, be it the first seedlings of an invasive exotic species or a rapid increase in a highly competitive native species, can usually be solved quickly, safely and at low cost. Problems that are not spotted, or are ignored, may quite rapidly develop into major management issues that carry high environmental and economic costs.

Consultations with nature conservation site managers revealed that a small number of chemicals were predominant among the herbicides currently used. In particular, the use of glyphosate (used on almost all sites), triclopyr, asulam, ammonium sulphamate, clopyralid and MCPA appears to be common – usually through carefully targeted applications, using spot-spraying, weed-wiping or stump application techniques, as appropriate. Other herbicides used less frequently on conservation sites include clopyralid + triclopyr, 2,4-D, fosamine-ammonium, mecoprop and clopyralid + 2,4-D + MCPA (Lonpar, Dow Agro Sciences).

## 1.2 Content of the Handbook

This Handbook summarises published research, advisory publications, legislation and codes of practice relevant to habitat management on nature conservation sites. All options are considered, but the most detailed information included is on the various herbicides that can be legally and effectively employed against the major problem species.

The Handbook is primarily intended for use by nature conservation site managers and advisers who require practical guidance on the technical merits, environmental risks and legal aspects of various herbicides that might be useful for the management of SSSIs and other nature reserves. However, it should also have a wider applicability, providing relevant information for farmers and land managers responsible for areas of land on which conservation management is an important objective.

This Handbook replaces the 1986 Nature Conservancy Council guide *The use of herbicides on nature reserves* (ed. by A S Cooke). That document considered only a very limited range of herbicides, which has now been substantially expanded. There have also been important new regulations and guidance on pesticide use introduced since 1986.

### 1.2.1 Key definitions

For the purposes of this Handbook, the following definitions are used:

**Pesticide** - any chemical or product approved for the purpose of killing or controlling the growth of any weed, disease or pest species. Includes wood preservatives, plant growth regulators, insecticides, fungicides and herbicides.

**Herbicide** - any chemical or product approved specifically for the purpose of killing or controlling the growth of any weed or other target plant species.

A full glossary of terms used is included at the end of the Handbook.

### 1.2.2 Environmental issues

Figure 1 (see 'How to use this Handbook') provides a simple summary of the main steps that should be followed by nature conservation site managers, when determining the most appropriate method to control a problem plant species. **The use of any herbicide will present some risk to non-target species – either directly or indirectly.** All pesticide users have a duty to ensure that these risks do not exceed the benefits of herbicide use, and that every reasonable action is taken to minimise risk. The environmental risks must, therefore, be properly assessed before pesticides are applied. This Handbook provides objective information that will aid the selection of a herbicide that presents the lowest possible risk to key species of conservation concern. However, available information on the impacts of herbicides on non-target species – in semi-natural habitats – is often scarce.

Even where 'high risk' herbicides (eg glyphosate, amitrole or triclopyr), with activity against a broad spectrum of plant species, are considered necessary, nature conservation site managers must have readily accessible information on how risks to non-target organisms can be minimised, by applying the chemical in the most appropriate way. Guidance is given on the method and timing of applications.

Although most herbicides have a relatively low toxicity to animal species (compared with insecticides), many can have significant indirect effects, eg by destroying food resources or nesting sites, or by depositing thick mulches of dead vegetation. These indirect effects are also considered.

Many herbicides pose a high risk to aquatic habitats. The Handbook clearly identifies those that can legally, and most safely, be used in or near water. It also outlines precautions that must be taken to ensure that pesticides do not contaminate watercourses.

### 1.3 Key references/Further reading

**BURN, A.** 2000. *Use of pesticides and veterinary medicines in agriculture*. English Nature Position Statement. Peterborough: English Nature. [www.english-nature.org.uk](http://www.english-nature.org.uk)  
**HMSO.** 1990. *This common inheritance, Britain's Environmental Strategy*. London: HMSO

## 2. Non-chemical methods for weed control

Areas of nature conservation interest are managed for wildlife gain. This includes controlling undesirable species. The first option is to consider non-chemical methods. Where relatively small numbers of plants are involved, removal by hand or machine can be carried out. If there are large quantities of vegetation to remove, regular grazing, cutting or burning may be more effective. Herbicide use may be necessary if these methods are unsuccessful or impractical.

Even where a decision is made to use herbicides, non-chemical methods may also have a role. For example, the risks to non-target species, or the effectiveness of a herbicide against the target species, might be improved by firstly cutting tall plants and then treating the re-growth. Or, the introduction of grazing livestock might be used to prevent re-occurrence of the problem.

### Further information on non-chemical methods can be found in:

**Blackshall, J., Manley, J., & Rebane, M., eds.** 2001. *The upland management handbook*. English Nature, Peterborough.

**Crofts, A., & Jefferson, R G.** 1999. *The lowland grassland management handbook*. 2nd Edition. English Nature/The Wildlife Trusts, Peterborough. [Note: The above handbooks can be downloaded as PDF files from the English Nature website: [www.english-nature.org.uk](http://www.english-nature.org.uk)]

**FACT.** 2001. *Practical solutions handbook*. 2nd Edition. English Nature, Peterborough.

**FACT.** 2003. *The Scrub Management Handbook – Guidance on the management of scrub on nature conservation sites*. Available from English Nature, Peterborough.

**Gimingham, G H.** 1993. *The lowland heathland management handbook*. English Nature, Peterborough.

**Grazing Animals Project.** 2001. *The breed profiles handbook – a guide to the selection of livestock breeds for grazing wildlife sites*. English Nature. Peterborough.

**Soil Association.** 2002. *Organic weed and scrub control on nature conservation sites*. Soil Association, Bristol.

species such as thistles, docks and nettles to thrive. For example, over-grazing in the winter or early in the season can encourage creeping thistle and can also allow it to spread. Any grazing regime should, therefore, be properly balanced (Soil Association 2002a, 2002b).

### Scrub

Goats are the most effective browsers of scrub, as they eat bark and leaves of woody plant species (Soil Association, 2002b). Some breeds of sheep, for example Hebridean, browse a wide range of shrub species. Grazing, in combination with other control methods, such as cutting or burning, can also effectively control some shrub species, eg willow, gorse and hawthorn.

### Ragwort

The control of common ragwort by sheep and goats is not specifically recommended, because of the toxicity of ragwort. But, the grazing of pastures when ragwort is at the rosette stage can be effective (Soil Association 2002a) because, although the plants may be toxic when young, the relative volume consumed is small. It is important, however, to ensure the availability of other palatable herbage.



Goats browsing scrub on Martin Down. Linda Smith/English Nature

### 2.1 Grazing and browsing

Grazing and browsing are often the preferred option for control and prevention of encroachment of certain scrub and weed species. They allow continual removal of seedling trees and bushes, and are useful for containing scrub species. Inappropriate grazing can, however, allow

### **Willowherbs**

Summer grazing can control great willowherb and other tall herb species and halt development of woody scrub. Rosebay willowherb is susceptible to trampling and is palatable to cattle, sheep, goats and horses. Autumn grazing has less effect on plant species which have already flowered and seeded (Crofts & Jefferson 1999).

### **Rushes**

Control of rushes by grazing with cattle or ponies after cutting can be an effective control method (Soil Association 2002a). Grazing can also be used to create a height differential to allow subsequent control of rushes by weed-wiper application of glyphosate (Crofts & Jefferson 1999). A combination of grazing and cutting can then be used to maintain this level of control.

### **Bracken**

Cattle trampling, in late winter and early spring, can be a useful component of a long-term control strategy for bracken (Crofts & Jefferson 1999; Soil Association 2002a) – but plenty of palatable herbage must be available as bracken is toxic to grazing animals (Southern Uplands Partnership 2001). Dense shading by trees can also reduce bracken vigour.

### **Alien species**

Sheep and cattle can be useful in the control of giant hogweed and hottentot-fig. Japanese knotweed is palatable to sheep, goats, cattle and horses. Grazing can suppress growth and may reduce spread, but will not eradicate the plant. Pony and deer grazing can be used to control shallon. Pigs can also be effective against shallon, uprooting plants rather than grazing them.

## **2.2 Environmental control**

Environmental and cultural control measures tend to be used as part of an integrated control programme, rather than in isolation. Cultural methods might include use of mulches or competitive plant species.

### **Shading**

Trees planted along narrow riverbanks can shade undesirable aquatic plants and contribute to their control. The addition of mulch mats can reduce additional competition from weeds when planting standards. Black plastic sheeting, or other materials to exclude light, is neither selective nor good aesthetically – although the use of such artificial shade materials may provide the only effective alternative to chemical control in certain situations, eg New Zealand pigmyweed infestations in aquatic areas (NERC-CEH 2002).

### **Water levels and flow rates**

Environmental control in aquatic and wetland environments involves altering conditions to make it less suitable for plant growth and survival. Water depth and velocity can be altered to reduce nutrient levels, which can control vegetation growth; and dredging lakes, for example, can increase water depth and prevent immediate re-growth (Seagrave 1988). Roworth (2000) found that by raising levels of water on a cut-over peat bog, significant areas of invasive birch died through waterlogging. Raising water levels after cutting rushes can also be an effective method of control for these species. This type of control can be important in many wildlife habitats, but dams can be difficult to install and have a limited life-span. There are, however, useful new alternatives to traditional dams (Bacon *et al* 2001).

## **2.3 Mechanical control**

Methods that remove roots, or starve roots of nutrients that will produce next year's shoots, are to be preferred to those that encourage coppice type re-growth. Methods can include removal by hand (eg pulling, levering, digging, cutting and raking) or by machine (eg pulling, bruising, crushing, strimming or mowing). The advantage of mechanical weed control, certainly if done by hand, is that it allows selective removal of vegetation. It can, however, be slow and expensive.

For aquatic weed control, digging, pulling, cutting and hoeing can be effective in removing vegetation; but these procedures are very labour intensive, so are generally unsuitable for larger water bodies (Seagrave 1988).

### **2.3.1 Weed pulling**

Hand pulling is often the best option for small infestations and has proven successful for species such as common and marsh ragwort, creeping thistle, spear thistle docks (Soil Association 2002a) and bracken. A combination of hand or mechanical pulling and reducing disturbance to soil can be effective against ragwort, if repeated over a number of years, without having to resort to herbicide use (Defra 2001c).

Hand pulling is also an effective method for controlling small infestations of Indian balsam, a shallow-rooted annual plant. Although not particularly effective against Japanese knotweed (Beerling *et al* 1994), individual mature stems and roots can be pulled manually to give other vegetation a competitive advantage. This technique would generally be most useful in particularly sensitive areas (Child & Wade 2000).





Weeding docks using Lazy Dog tool. John Bacon/English Nature

Lazy Dog tools can be used to extract weeds such as docks, thistles, ragwort, small tree saplings and nettles (Bacon 2000). The Rag-Fork is a similar tool, specifically designed for pulling just ragwort (Bacon *et al* 2001).

For larger infestations, weed pulling using an *Eco-puller* can be effective against ragwort, thistles, nettles and other tall weeds, including rosebay willowherb (Clay 2000; Bacon *et al* 2001; Jefferson & Robinson 2002). For perennial species, this method can result in a year-on-year reduction in the number and vigour of flowering stems; though pulling is required in successive years. It is however non-selective – all tall plant material will be pulled. For longer-term effectiveness against infestations of perennial species such as common nettle, mechanical pulling must be repeated over a number of years (Defra 2001b)

### 2.3.2 Cutting, mowing and crushing

#### Trees and shrubs

Dense areas of birch or gorse can be knocked down using high horse-power machines operating flails. The method has value in some situations especially where grazing can follow, without which re-growth from remaining stumps can be vigorous and require repeat operations at frequent intervals. Costs can be very high.

Shaw (1984) found that frequent cutting could have an impact on rhododendron as long as the cuts took place at the correct time of year. Cutting tends to be followed by either removal of debris, burning or chipping (Mortimer *et al* 2000). Plants can become re-established from cut stems or wood chips.

#### Bracken

To control bracken cutting or crushing the fronds twice a year can be effective (Crofts & Jefferson 1999). Cutting always requires follow-up treatment. Le Duc *et al* (2000) found that annual cutting of bracken was the best long-term solution; although, in the short-term, a combination of cutting and spraying achieved the best results. Mechanical control of bracken has little direct effect on other plants, but can have an indirect effect by altering the physical environment (Williams *et al* 1988).

Bracken ‘bruising’ is another technique that is used to damage the stems of bracken, reducing the vigour and number of stems in the next year (Lewis *et al* 1997; Bacon *et al* 2001; Soil Association 2002a). There are various ‘bracken bruiser’ machines designed specifically for wildlife sites (Bacon *et al* 2001). Timing can be critical – the optimal time being just after bracken fronds have fully expanded – although care must be taken to minimise risks to reptiles and ground-nesting birds.

#### Ragwort

Cutting is not a suitable option for ragwort, as growth is stimulated and plants may become perennialised subsequently re-flowering later in the season or next year (Soil Association 2002a). Wilted cut material can be particularly hazardous to livestock.

#### Thistles

Repeated cutting can reduce seeding of creeping thistles and over several years can exhaust the food supply in the roots (Soil Association 2002a); but treatment should be repeated more than once a season, because stands of creeping thistle are usually unevenly matured (Simpson 1993).

#### Docks

Cutting can prevent seeding of docks, but does not actually kill plants – in some cases they can grow new shoots following defoliation (Simpson 1993). Repeated cutting of docks may, however, ‘exhaust’ nutrient reserves in the root system and is often recommended as an important component of an integrated control strategy.

#### Willowherbs

Cutting and pulling over a number of years can also reduce vigour and cover of rosebay willowherb, though at least two cuts per year would normally be required (Jefferson & Robinson 2002).

### Nettles

Cutting is not a particularly effective method of controlling common nettle, though it does prevent seed production. Regular cutting and trampling can also provide some control followed by re-seeding of bare ground (Fryer & Makepeace 1978).

### Rushes

Cutting (followed, if possible, by grazing or flooding) is a key component of non-chemical programmes for the control of rushes (Soil Association 2002a).

### Alien species

Although a useful pre-treatment to herbicide application, cutting treatments alone have not been effective in the control of giant hogweed (Tiley & Philp 1994, 2000). Chopping roots below ground level can be effective, especially if carried out at the flowering stage, but is labour intensive. Frequent cutting of plants can lead to reduced growth, but non-flowering vegetative plants can take several years to kill, due to sizeable root reserves. If cutting is delayed until after flowering, mature fruits can develop from plant reserves in the severed stem (Dodd *et al* 1994). Lawrie & Clay (1993a) also found cutting and burning to be ineffective.

For Japanese knotweed, repeated cutting is labour intensive and its long-term success is uncertain, due to the longevity of its rhizome system – although it can reduce vigour. In addition, cut material has to be removed to prevent further spread (Soil Association 2002a). Cutting can be used to reduce plant height, to prepare a site before application of herbicides, or to remove dead stems. Flail mowing is not a recommended practice for this species, as it can spread fragments of stem material into previously non-infested areas (Child & Wade 2000).

Small stands of Indian balsam can be controlled by cutting or pulling, but these methods tend to be ineffective for larger stands, which often require use of herbicides. Frequent mowing is another option, but both cutting and mowing have to be carried out before the seed pods are formed, to prevent re-growth from seed (CAPM 1997a).

### Aquatic weeds

Cutting of many aquatic weeds provides short-term control, with little effect on fish and invertebrate populations (MAFF 1995). Cutting is effective against emergent and rooted weeds, but not against free-floating weeds, filamentous algae or unicellular algae. Cutting can also be used for vegetation on riverbanks as long as the vegetation is removed and does not enter the water.

Weed-cutting boats are effective for cutting large quantities of submerged and emergent weeds and are suitable for larger water bodies; however, they are expensive and can

stimulate re-growth. Tractor-mounted cutters are useful for cutting weeds along rivers if the bankside is accessible, but there are again problems with re-growth and the cutting distance is restricted by the length of the cutting arm (Seagrave 1988).

Where weed cutting has taken place in static water, all cut vegetation has to be removed from the water; otherwise it will rot and cause a depletion of dissolved oxygen. Dredging and raking can also be effective control methods. Dredging provides long-term control, but is not selective and affects the whole water body. Raking can be an effective control method for windblown weed, but is not suitable for large water bodies.

Dawson & Warman (1987) investigated the removal of New Zealand pigmyweed, manually and by machine, but these methods proved unsuccessful on many occasions because of the re-growth potential of the plant. Small fragments broken off during mechanical control can re-grow and spread the infestation downstream.

### 2.3.3 Digging and stump excavation

Re-growth from cut stumps will occur in most broadleaved tree and shrub species (exceptions include broom and beech) and can be very vigorous in species such as horse chestnut, rhododendron, sycamore, birch and willows. Mattocks and equivalent tools can be used to cut out tree and shrub saplings and stumps below ground level, to prevent re-growth. Although these tools limit ground disturbance, they are labour intensive and some species still send up shoots from remaining roots (eg blackthorn, dogwood, privet, snowberry, wild cherry and willows).

A new technique, suitable for some soil types, uses an adapted chainsaw to cut sapling roots below ground level, causing minimal ground disturbance. It has been particularly recommended for use on species such as alders, beech, birch, broom, elder, hawthorn, hazel, horse chestnut, maples, oaks, sycamore, sweet chestnut and whitebeam (Soil Association 2002a). However, the saw is only suitable for use on small and medium sized sapling roots, and cannot be used on sites with an abundance of



Root cutting chainsaw and mattock. John Bacon/English Nature

hard stones or rocks (Bacon *et al* 1998; Soil Association 2002a). Mechanical stump grinders can be used to prevent or minimise re-growth from larger trees and shrubs after they have been felled and removed.

Digging Japanese knotweed plants and rhizomes is labour intensive and, on its own, not particularly effective, as even very small rhizome pieces can readily grow (Palmer 1994). It can also encourage spread, as parts of rhizomes can break off and re-grow around the site of the original stand.

Mechanical extraction of tree or shrub stumps is expensive and can cause unacceptable disturbance of soils and vegetation across a site. In certain circumstances, however, it might be considered necessary and employed effectively. For example, a tracked excavator, fitted with a rake attachment, proved effective in clearing sea buckthorn from dune slopes and hollows on a coastal nature reserve (Rooney 1998).

#### 2.3.4 Other mechanical methods

**Infra-red** control is an option which has been widely used in countries such as Holland (Bacon *et al* 2001). It uses less energy than a flame gun and exposes plants to a stream of radiated heat. It could be suitable for trials in conservation sites, as there is no disturbance to soil, control is not weather-dependent and it permits more efficient use of energy. Larger versions are non-selective, so are unsuitable for controlling individual weeds, and there is limited penetration below ground - so re-growth may occur from deep-rooted species (Bacon *et al* 2001).

**Hot foam** weed control technique using a biodegradable organic foam applied from a specially developed machine (Waipuna; email: gporxxx@xxxxxxx.xxx) is currently being trialed for weed control on a range of weeds and this may have application to many situations (Andrew Sharkey, pers comm).

## 2.4 Biological control

Biological control is often aimed at controlling naturalised weeds and frequently uses the plant's natural enemies to lower its density (Bovey 2001). It is generally intended to suppress weed populations, thus allowing native species to re-establish (Charudattan 2001).

There are two main types practised:

- Introduction of non-native species ('classical biocontrol'), and
- Manipulation of indigenous populations, either through conservation of existing predator or parasite populations or 'augmentation' (eg through regular releases of biocontrol agents).

In both of these situations, the objective is to use organisms that can restrict the growth and development of target weeds, without disturbing non-target organisms.

A disadvantage of biological control is that it can be slow and often involves a reduction in spread of weeds rather than complete eradication (Fowler 1993). Control tends to be specific to one or a few weed species, so is generally unsuitable for areas where rapid control is required of many different weed species. It also carries serious risks as it can potentially damage rare native species, so this should only ever be considered with great caution and after thorough research.

In its favour, biological control tends to be permanent – and consequently very cost-effective in the longer-term (Fowler 1993). It is also suitable for use in areas where mechanical or chemical control is unachievable, due to the terrain.

McFadyen (1998) reviewed the use of biological methods for the control of weeds across the world and found that classical biological control - involving the introduction and release of exotic insects, mites or pathogens to give permanent control - was much more widely used than inundative releases of predators or integrated pest management. She also reported that biological control was most commonly practised in the USA, Australia, South Africa, Canada and New Zealand with weeds in natural ecosystems being increasingly targeted by biocontrol programmes. Biological control of aquatic species has been particularly successful.

CABI Bioscience, a division of CAB International, leads UK research on biological control. For more information, see their website at [www.cabi-bioscience.org](http://www.cabi-bioscience.org)





Cinnabar moth larva. Roger Key/English Nature

### Bracken

The potential for using introduced herbivorous insects to control bracken was investigated by Fowler *et al* (1989) and Fowler (1993). Two southern African moths *Conservula cinisigna* and *Panotima* sp. are potentially suitable. Both species are abundant in the colder, wetter regions of southern Africa, which are climatically similar to the UK. Field observations made by Rashbrook *et al* (1990) & Lawton (1990) indicated that the moths are highly damaging to the plant and both might be good candidates for release in Britain.

**Mycoherbicides** may be another option and have been investigated by Burge *et al* (1986) for controlling bracken. They also have the potential to control many other weeds (Holden *et al* 1992).

### Ragwort

Two native species with potential value are the cinnabar moth, whose larvae feed on ragwort (Simpson 1993) and ragwort flea beetles, which have been used to control ragwort in the USA (Hawkes 1981). An assessment of control using UK-bred cinnabars has been recently undertaken and appears in Appendix 3 of a ragwort information leaflet (English Nature 2003). Release onto SSSIs would not normally be approved.

### Thistles

The unsuccessful release in the UK of the chrysomelid beetle *Altica carduorum*, in an attempt to control creeping thistle, was reported by McFadyen (1998) as the only European release of a biocontrol agent outside of the former USSR. Biological control of this species is likely to be very difficult to achieve, but potential candidate control agents might include a tephritid fly *Urophora cardui* and the larvae of certain weevil species. The combined use of a rust pathogen and a low dose of 2,4-D can severely damage thistles and may, in the future, provide another possible option for long-lasting control.

### Docks

No invertebrates have yet been found to give effective control of docks, in most situations; although the beetle *Gastrophysa viridula* may eradicate docks if used in conjunction with modification of environmental conditions, eg flooding. There are, however, a number of fungi which are potential control agents (Simpson 1993).

### Alien species

Holden *et al* (1992) investigated the possibilities for biological control of various invasive plants (Japanese knotweed, rhododendron, giant hogweed), but noted that where target weeds are closely related to native plants, it may be more difficult to find specific agents to control the target without damaging the native plants. For rhododendron this may be a problem, as it has many related species and hybrids used as ornamentals. CABI BioScience has collected a number of herbivorous insects and pathogenic fungi from Japanese knotweed in their native habitat, which might, in the long term, provide potential biological control agents for this very problematic weed (Shaw 2002).

### Aquatic weeds

For aquatic vegetation, in isolated ponds or landlocked lakes, biological control using grass carp can be used to control submerged or floating weeds (DoE 1992). The carp help control growth by stirring up sediment and making the water turbid. However, grass carp can also encourage growth of unicellular algae and the fish are susceptible to predation by pike (MAFF 1995). It can also be difficult to get permission to stock them and they are generally expensive to buy (Seagrave 1988). Crayfish can reduce the biomass of submerged weed but, again, it is difficult to gain permission to stock them and they only thrive in areas of high water quality (Seagrave 1988).

Dawson & Warman (1987) looked at the use of herbivorous grass carp to eat the problem species New Zealand pigmyweed, but this required fairly deep and permanent water of a certain temperature, and New Zealand pigmyweed is not their preferred food species.

## 2.5 Key references/Further reading

- Bacon, J.** 2000. Weed control... with a Lazy Dog?! *Enact*, 9(1), pp.19-20.
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## 3. Using herbicides – general guidance

### 3.1 Legal requirements

The distribution, sale, storage, use and disposal of any pesticide is regulated by various pieces of UK and European legislation, and related codes of practice. These are summarised on the PSD website ([www.pesticides.gov.uk/legislation](http://www.pesticides.gov.uk/legislation)) and in the latest edition of *The UK pesticide guide* (Whitehead 2003). In the context of herbicide applications on nature conservation sites, the most important among these are:

- The Food and Environment Protection Act 1985 (FEPA) (Part III)
- The Control of Pesticides Regulations 1986 (COPR) – as amended by The Control of Pesticides (Amendment) Regulations 1997
- The Control of Substances Hazardous to Health Regulations 1988 (COSHH)
- EC Directive 91/414/EEC (The ‘Authorisations’ Directive), implemented through:
  - The Plant Protection Products Regulations 1995 (as amended by various Plant Protection Products (Amendments) Regulations (PPPR), and
  - The Plant Protection Products (Basic Conditions) Regulations 1997 (PPP(BC)R).
- *The water code. Code of good agricultural practice for the protection of water* (MAFF/WOAD 1998).

The Pesticides (Maximum Levels in Crops, Food and Feedingstuffs) (England and Wales) Regulations 1999, which was amended in 2001, although important for agricultural and horticultural pesticide users, is not relevant to herbicide use in nature conservation sites.

This legislation also covers Scotland. Similar legislation exists for Northern Ireland.

The requirements of the Weeds Act 1959, relating to the control of five specified ‘injurious weeds’, and provisions under the Wildlife and Countryside Act 1981 for the control of Japanese knotweed and giant hogweed are also relevant, and are discussed at the end of this section.

### 3.1.1 FEPA and COPR

The Food and Environment Protection Act 1985 (FEPA) gives a very broad definition of the term **pesticides**, which includes all herbicides, fungicides, insecticides, rodenticides, soil sterilants, wood preservatives and surface biocides.

FEPA provides statutory powers to control pesticides. Section 16 of the Act states that the controls within the Act have four overall aims. These are:

1. To protect the health of human beings, creatures and plants;
2. To safeguard the environment;
3. To secure safe, efficient and humane methods of controlling pests; and
4. To make information about pesticides available to the public.

### Pesticide approvals

Under the terms of the Control of Pesticides Regulations (COPR) (as amended), only approved products can be sold, supplied, stored, advertised or used. More specifically, pesticides can only be used in situations for which their use is currently approved by five Departments. These include the Department for Environment, Food and Rural Affairs (Defra) (Pesticides Safety Directorate) and the Department for Work and Pensions (the Health and Safety Executive). Lists of currently approved pesticides have been published annually in the PSD/HSE guide *Pesticides*. However, from 2002 onwards, lists will be only available from the PSD website ([www.pesticides.gov.uk](http://www.pesticides.gov.uk)) which will be regularly updated.

**It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use**, including where the crop or situation is the subject of an off-label extension of use.

Chemicals that are derived from natural sources (eg plants) are subject to the approvals process, in the same way that man-made pesticides are.

Biological control agents may also be classified as pesticides, although only micro-organisms used for this purpose are subject to the pesticide approvals process. Biological control agents that are not micro-organisms do not require approval.

It is important to note that, with the exception of certain commodity chemicals, approvals for herbicides, as for all pesticides, are based on formulated products - not the chemically active ingredients.

Users of pesticides must comply with the Conditions of Approval relating to use. Consequently, all pesticide users must read carefully the product label before use. In the case of a chemical being applied under the terms of a commodity approval or off-label approval, it is the user's responsibility to obtain, read and retain the appropriate Notice of Approval published by Defra.

There are four types of approval under COPR:

- **Emergency** – approval for sale, supply and use only (for a limited period);
- **Experimental** – approval for supply, storage and use only (for a limited period);
- **Provisional** – approval for sale, supply, storage, use and advertisement (for a stipulated period); and
- **Full** – approval for sale, supply, storage, use and advertisement (for an unlimited period).

Products granted only an experimental approval cannot be advertised or sold and do not appear in the PSD/HSE list of approved products.

New approvals are notified via the monthly PSD/HSE publication *The pesticides monitor*.

These types of approval relate only to products containing active ingredients on the market by 25 July 1993. Products containing newer active ingredients, or older ingredients subsequently listed in Annex I to EC Directive 91/414/EEC, will be granted approval under PPPR (see below), although the categories used are very similar.

#### Off-label use

Pesticide products may also, in some circumstances, be used in a way that is not specified on the product label. Products may either have a Specific Off-Label Approval (SOLA) for an alternative 'minor use' or be covered for a particular purpose under *The long-term arrangements for extension of use* (2000). These are due for revision before 31 December 2004. Users should be aware that there is a risk that pesticides used under an 'off-label' approval may not be as effective. However, all statutory

conditions relating to approved uses of the pesticide concerned, and any conditions specified on a SOLA Notice of Approval or commodity chemical approval, must be complied with. The application method must also be as stated in the approval and described on the product label.

Under certain conditions, the use of reduced spray volumes may also be legal. Further guidance is provided in the *Code of practice for the safe use of pesticides on farms and holdings* (the 'Green Code').

#### Adjuvants

Adjuvants are substances, other than water, added to enhance the effectiveness of a pesticide, eg extenders, wetting agents, sticking agents or fogging agents. They are not classed as pesticides. However, COPR still stipulates that **only authorised adjuvants may be used with pesticides**. The product label for an adjuvant stipulates the circumstances in which it may be used and should be consulted. The label will also include details of the pesticides that the adjuvant can be mixed with. As for pesticides, the current list of authorised adjuvants can be viewed on the PSD website.

#### Tank mixes

**The regulations forbid the preparation of tank mixes of two or more pesticides, unless all of the conditions of approval set for the pesticides concerned are complied with.**

#### Protection of water

FEPA places a special obligation on all pesticide users to safeguard the environment and to prevent pollution of water. No pesticides may be used in or near water, unless the approval specifically allows such use. MAFF published *Guidelines for the use of herbicides on weeds in or near watercourses and lakes* which were revised in September 1995. These guidelines cover ponds, lakes, reservoirs, rivers, streams, canals, drainage channels and dry ditches, and include guidance on the control of vegetation on riverbanks and other immediately adjacent land.

**The Environment Agency (or the Scottish Environment Protection Agency) should always be consulted before any application of herbicides to areas of water.**



### Buffer zones

Some products that are potentially most damaging to aquatic species have a legally binding requirement to leave an unsprayed 'buffer strip', of a minimum specified width, adjacent to any water body (now measured from the top of the bank, rather than the water's edge). Buffer zone restrictions do not always apply to all products containing the same active ingredient.

The width of a buffer zone for applicable pesticide products was previously set at two metres for hand-held sprayers, six metres for tractor-mounted sprayers and 18 metres for broadcast air-assisted sprayers (eg orchard sprayers). However, the introduction of Local Environment Risk Assessments for Pesticides (LERAPs) in March 1999, has given pesticide users the possibility of reducing these distances - if his/her documented assessment concludes that water pollution risks are low (eg because of use of

reduced pesticide dose or low drift spray nozzles, or if a drainage ditch is dry at the time of spraying.)

The protection of watercourses is further supported by the Water Resources Act 1981, which made it an offence to pollute any controlled waters (watercourses or groundwater), either deliberately or accidentally.

New groundwater regulations were introduced in 1999 to complete implementation of the EC Groundwater Directive (80/68/EEC). These regulations control discharges or disposal of certain substances, including all pesticides. However, normal use of pesticides, including spraying washings and rinsings back onto the 'crop', is not affected.

Buffer zones for specific herbicides, based on experimental results, were recommended by Cooke (1993) and are listed in Table 1 below.

**Table 1. Recommended buffer zones for the protection of selected plant groups.**

Application from ground or air	Species at risk	Buffer zone (m)
Ground	Heathland lichens	0
Ground	Pasture woodland lichens	0, but avoid direct spraying
Ground	Established higher plants	10, except for glyphosate with some species
Ground	Seedling higher plants	Up to 20

### Certification of advisers and spray operators

Both COPR and PPP(BC)R set out requirements for minimum levels of competence needed by people who supply or apply agricultural pesticides, and those who advise others on the use of such pesticides. Anyone who gives advice when selling or supplying a pesticide approved for agricultural use (this definition includes products approved for horticultural, forestry, aquatic, amenity or industrial uses) must have a recognised Certificate of Competence. In effect this means that they should be 'BASIS (British Agrochemical Standards Inspection Scheme) qualified'. BASIS (Registration) Ltd (Ashbourne, Derbyshire) is the only organisation recognised by Government under the legislation to issue such certification.

New staff entering the pesticides industry as salespersons or technical advisers must obtain BASIS registration within three years. In the interim period they must work under the supervision of a qualified colleague. Pesticides advisers who are not actually selling agricultural pesticides have no legal requirement to be certificated. However, many leading consultancy organisations ensure that all of their staff giving pesticides advice are BASIS qualified.

Contractors who use agricultural pesticides as part of a commercial service also require certification unless born before 31 December 1964 or under the direct and personal supervision of someone who holds such a certificate. All users are obliged to take all reasonable precautions to protect the health of human beings, creatures and plants, to safeguard the environment and to avoid the pollution of water when using a pesticide.

Advice given by sellers, advisers or contractors which subsequently proves to be incorrect, may constitute an offence.

More details of BASIS qualifications and training requirements for spray operators are given in Section 3.3.

Further guidance for those selling or supplying agricultural pesticides is contained in the *Code of practice for suppliers of pesticides to agriculture, horticulture and forestry* (the 'Yellow Code').

### Aerial applications of pesticides

Only certain pesticide products are approved for aerial application and strict rules apply for all aerial spraying operations. Anyone proposing an aerial pesticide application within 1,500 m of an SSSI, National Nature Reserve or certain other designated conservation sites must consult English Nature, Scottish Natural Heritage or the Countryside Council for Wales at least 72 hours before spraying commences. If the land to be treated is adjacent to or within 250 m of water, then the Environment Agency (England and Wales) or Scottish Environment Protection Agency (SEPA) must be consulted at least 72 hours in advance of spraying. If the intention is to control weeds in or near water, then the consent of the Environment Agency or SEPA must be obtained before spraying.

Herbicides approved for use by aerial application include asulam (*Asulox* and *IT Asulam*). *Asulox* and *IT Asulam* have approvals for aerial spraying in forestry, agricultural grassland and rough upland intended for grazing. *Asulox* has approval for use on amenity grassland and *IT Asulam* is approved for use on amenity vegetation.

#### 3.1.2 COSHH

The Control of Substances Hazardous to Health (COSHH) Regulations came into force in October 1989, under the Health and Safety at Work Act 1974. They require that pesticides should only be used where necessary, and where the benefits significantly outweigh the risks to human health and the environment. A pesticide selected for use in any particular situation should be that which poses least risk to people, livestock and the environment – whilst still being effective against the target species. Employers and self-employed spray operators are required to perform risk assessments, to validate their choice of chemical.

The COSHH Regulations also lay down the basic requirements for the assessment and control of exposure to pesticides and other hazardous substances. Substances deemed to be 'hazardous to health' include those labelled as 'toxic', 'very toxic', 'harmful', 'irritant' or 'corrosive'. Exposure of employees to these chemicals must be prevented or adequately controlled.

#### 3.1.3 The 'Authorisation' Directive and PPPRs

EC Directive 91/414/EEC is intended to harmonise arrangements for the authorisation of plant protection products within the European Community. In the UK, it is implemented through the Plant Protection Products Regulations (PPPR) (Anon 1995), – under which all agricultural and horticultural pesticides will eventually be regulated.

The PPPR assigns approved products to one of four categories, in a similar way to COPR. The levels of PPPR approval are:

- **Emergency** – approval for sale, supply and use only (for a limited period);
- **Experimental** – approval for supply, storage and use only (for a limited period);
- **Provisional** – approval for sale, supply, storage, use and advertisement (for a stipulated period, not exceeding three years); and
- **Full** – approval for sale, supply, storage, use and advertisement (for a period, not exceeding 10 years).

#### 3.1.4 Codes of practice

**The Defra Water code** (MAFF 1998) provides valuable guidance on pesticide storage and use and on the disposal of waste pesticides. It also includes specific guidance on issues such as dealing with chemical spillages, applying pesticides near water, minimising waste pesticide and disposal of containers.

**The 'Yellow Code'** (*Code of practice for suppliers of pesticides to agriculture, horticulture and forestry*) (MAFF 1990) provides practical guidance for those involved in the sale, supply and storage of "pesticides approved for agricultural use" on how to comply with the requirements of FEPA, COPR and The Plant Protection Products (Basic Conditions) Regulations.

**The 'Green Code'** (*Code of practice for the safe use of pesticides on farms and holdings*) (MAFF/HSE 1998) advises pesticide users on safe use of pesticides in accordance with the requirements of COPR, PPPR and COSHH.

**The safe use of pesticides for non-agricultural purposes** (HSC 1995) is an approved code of practice giving practical guidance on the use of non-agricultural pesticides in accordance with the requirements of the COSHH Regulations 1994.

#### Pesticide storage

Pesticides must be securely stored under appropriate conditions. For small quantities this may be a suitable, lockable chest, bin, vault or cabinet, clearly marked with a hazard warning sign. The container used must be resistant to impact and fire. To ensure that any leakage from pesticide packs and bottles is safely contained, containers must have a built-in sump big enough to contain the total amount of pesticide stored.



For larger quantities, a carefully designed designated storage room may be required. Pesticide stores must be soundly built from fire-resistant materials and have an impermeable floor, to contain any spilled chemicals. The impermeable floor, in conjunction with a leak-proof door, sill and walls, should form a sump capable of containing a total volume at least 85% above the total volume of pesticides held in the store (total volume +10% for stores that are not in environmentally sensitive areas). Again the store must be locked and clearly marked with a hazard warning sign.

If building a new pesticide store, or substantially modifying an existing one, advice should first be sought from the Environment Agency, local planning and fire authorities, crime prevention officer and the HSE.

For more detailed information on pesticide storage, refer to HSE Agricultural Information Sheet 16: *Guidance on storing pesticides for farmers and other professional users*. HSE Books, 1996.

### **Pesticide handling and dealing with spillages**

Spray equipment should be filled and washed in a designated area from which spillages cannot escape, well away from drains, ditches or surface water.

Care must be taken to avoid spillages, but if they do occur then prompt action must be taken to limit the effects and, if appropriate, warn others (eg the Environment Agency). Small spills should be soaked up with an absorbent material such as sand. The contaminated absorbent should be subsequently disposed of through a licensed waste disposal operator.

Major spills must be contained and the Environment Agency promptly alerted (telephone their emergency hotline: 0800 807060).

**Never hose down a spillage or simply leave it to dry – these actions will increase the risk of water pollution.**

### **Disposal of pesticides and tank washings**

It is illegal to store pesticides that are no longer approved. In most cases, unwanted pesticides must be disposed of using a registered waste disposal operator.

Where appropriate and possible, tank washings (after spraying has been completed) should be stored for use in the next batch of diluted pesticide. If this is not feasible, the *Water code* recommends that the washings should be either:

- sprayed onto a previously treated area of crop – as long as this is within the terms of the product approval and does not exceed any stated maximum dose, or
- sprayed onto an untreated crop area – if this is within the terms of the product approval and there are no watercourses nearby, or
- stored in a suitable container until a registered waste disposal operator collects it.

There are other alternatives for the disposal of tank washings that require prior approval from the Environment Agency or the local Water Services Company (WSC). These include:

- spraying onto an area of uncropped land, not stubble or fallow, of minimal wildlife value, or
- using equipment designed to treat liquid waste that contains pesticides, or
- subject to a consent from the local WSC and the Environment Agency for substances prescribed under the Water Act 1989, emptying the liquid into a public sewer.

In England and Wales, substances prescribed under the Water Resources Act 1991 cannot be emptied into a public sewer without prior consent from the local WSC and the Environment Agency – even if they have been treated by specialist equipment. Herbicides included in the list of prescribed substances include atrazine, simazine and trifluralin.

### **3.1.5 The Weeds Act, 1959**

The Weeds Act 1959 specifies five ‘injurious weeds’ that are considered as potentially serious threats to agricultural production. The weed species covered by the Act are:

- spear thistle (*Cirsium vulgare*)
- creeping thistle (*Cirsium arvense*)
- curled dock (*Rumex crispus*)
- broad-leaved dock (*Rumex obtusifolius*)
- common ragwort (*Senecio jacobaea*)

Landowners have a responsibility to control these weeds. In circumstances where control is thought to be inadequate, initial complaints should (ideally) be made to the occupier or owner of the land concerned. If this is not successful, complainants should approach the local Defra Regional

Service Centre. A Defra investigation should then follow, which may subsequently lead to the issue of an official notice requiring the occupier or owner to take prompt action to control the spread of the weed(s) concerned.

However, Defra's responsibilities are for agricultural land and livestock, rather than animals kept for non-agricultural businesses or recreational purposes. Consequently, Defra are unlikely to pursue complaints unless officials perceive a clear threat to agricultural land. Complaints about injurious weeds threatening land used solely for the grazing of horses, ponies or donkeys are not normally investigated. (Important note: the production of a draft of Defra's *Code of practice to prevent and control the spread of ragwort* was occurring as this Handbook was going to print. Guidance on the draft and new enforcement procedures by Defra under the Weeds Act is likely to mean that complaints about the threat the weed poses for horse welfare will be given the same priority as for other livestock).

Reports to Defra of injurious weeds growing on National Nature Reserves (NNRs) or SSSIs will be taken up with English Nature. Where the reported problem is on a Local Nature Reserve established by a local authority, Defra will contact that authority. As 'standard' weed control measures may be inappropriate on many nature conservation sites – and, on a NNR or SSSI, English Nature may have notified weed control as a potentially damaging operation – the appropriate action will be determined in consultations between Defra and English Nature.

### 3.1.6 Wildlife and Countryside Act 1981

Under Section 14 of the Wildlife and Countryside Act 1981, it is an offence to "plant or otherwise cause to grow in the wild" certain specified plants, listed in Schedule 9, Part II of the Act. The only two vascular plants listed are Japanese knotweed and giant hogweed. This may be relevant to nature conservation site managers who use mechanical methods to control these species, as inappropriate disposal of plant material may cause new infestations if new plants arise from seeds or buried stem, root or rhizome fragments.

(Schedule 9, Part II of the Act also includes several species of marine algae, eg hooked asparagus seaweed, giant kelp, red Californian seaweed and wakame).

The requirements of the Wildlife and Countryside Act and related requirements of the Environmental Protection Act 1990 are particularly pertinent to nature conservation site managers taking measures to control Japanese knotweed. This species can be easily spread through the distribution of stem, rhizome or crown fragments. For this reason, the Environment Agency recommends that

any cutting of Japanese knotweed is done by hand, using sharp hooks or slashers rather than by mechanical flails or mowers, which can cause the plant to spread. Cut stems, excavated crowns or rhizomes of Japanese knotweed and soil contaminated with rhizomes must be disposed of on site or safely transferred to a licensed landfill operator. The preferred (and much less expensive) option for plant material to be disposed of on site should be thoroughly dried and, if local bylaws permit it, burnt.

Cut vegetation or soil contaminated with Japanese knotweed rhizomes is regarded as 'controlled waste' under Section 34 of the Environmental Protection Act. Consequently there is a 'duty of care' placed upon landowners, managers and contractors to ensure safe disposal in accordance with the provisions of the Act. Any Japanese knotweed waste that leaves the site of origin must be securely transported to a licensed landfill site, where it must be buried to a depth of at least five metres.

## 3.2 Methods and timing of application

### 3.2.1 Application methods

The method used to apply a herbicide will depend on several factors. These include:

- the extent and distribution of target species;
- the height and structure of target species;
- the height, structure and sensitivity of surrounding/ adjacent crop or other non-target species;
- the terrain over which the herbicide is to be applied; and
- the approval requirements as described on pesticide labels, which take into account factors such as mode of uptake, efficacy and operator safety.

Pesticides must be applied by means that comply with the conditions of the product approval. However, unless the approval places a legal requirement on the user to use a specific type of equipment, or specifically prohibits an alternative method, an alternative method of application may be used, provided that:

- a. the equipment chosen is suitable for the intended application of pesticides;
- b. a suitable and sufficient COSHH assessment has shown that the alternative method of application does not involve an increased risk to health and safety;
- c. an assessment of the environmental effects of using the pesticide by that application method has been made; and

- d. the necessary control measures to reduce the risks, so far as is reasonably practical, are in place.

Herbicides may be applied pre- or post-emergence, as sprays or granules, to soil or foliage, according to the approval conditions. Applications can be to selected patches or spots of target weeds (spot treatment), to bands (eg along tree rows) (band application) or uniformly across a larger block of land or whole field (overall spray).

The types of sprayer or other herbicide application equipment most likely to be used in nature conservation sites are listed below in decreasing order of targeted application and their main uses and features described.

### Stem injection

Translocated (systemic) herbicides, such as glyphosate (eg *Rival* or *Roundup Pro Biactive*) or triclopyr (eg *Timbrel* or *Garlon 4*), that move throughout the plant, are sometimes 'injected' directly into the stems of unwanted trees or large shrubs. The herbicide is applied into the xylem of the target trees and shrubs via spaced cuts made around the trunk of the tree using an axe, hatchet or purpose-made tree injector.

One technique involves using a hatchet to make a series of horizontal, angled, downward cuts into the bark of the tree, making a discontinuous 'frill' around the lower trunk. A small amount of translocated herbicide (eg glyphosate) is then sprayed into each cut. This may be done using a small hand-sprayer, spraying down the inside edge of the hatchet blade. This is, generally, a more effective method for killing unwanted trees than simply 'girdling' the trunk with an axe. Alternatively, granules of *Amcide* or *Root-Out* (both ammonium sulphamate) can be placed in frills, notches or holes in tree or shrub stems.

Another potential method of stem injection involves the use of small plastic capsules, containing herbicides such as glyphosate, which are screwed or hammered into the stems of trees or shrubs. One example, which is not currently registered for use in the UK, is the *Ecoplug* – originally developed in Sweden in 1990 ([www.ecoplug.com](http://www.ecoplug.com)) and used in several countries throughout the world. The *Ecoplug* is a "paper-clip sized" plug containing granular *Roundup* (glyphosate) which is hammered into a small hole drilled into the base of an unwanted tree or tree stump. The hammering action releases the herbicide into the tree stem. The granules quickly dissolve in the tree's sap and the herbicide is translocated to the root system.

These methods pose little or no risk to non-target plants, as herbicides enter directly into the inner tissues of the undesirable tree or shrub, with almost no risk of soil and water contamination.

### Paintbrushes

Freshly cut stumps of unwanted trees, large shrubs or woody climbers can be treated with a herbicide (eg glyphosate), carefully applied using a paintbrush. For this purpose, the herbicide might be applied mixed with a water-based gel or as a concentrated solution, eg undiluted chemical or 1:1 solution with water. As for cut stump sprays, better results are likely if treatment follows immediately after cutting the stems. This avoids missing the treatment of some stumps at a later date and avoids the stumps drying up, thus reducing efficacy. Treated stumps should be marked with a dye to ensure 100% treatment. The risks to non-target plants should be negligible if this method is used properly.

### Weed-wipers

Weed-wipers (eg wick, carpet or roller applicators) allow the safer treatment of taller target vegetation, reducing the exposure of shorter, non-target species to herbicides. They involve a herbicide-soaked wipe head, that continually draws chemical from an integral reservoir. The wipe head is drawn over, or wiped against, target weed plants. This directly applies herbicide to stems and foliage and avoids any drift onto non-target plants. (NB Only four herbicides are approved for use with weed-wipers (see Table 4). These are glyphosate (various), 2,4 D + dicamba + triclopyr (Broadsword or Nuform Nu-shot), clopyralid + triclopyr (Grazon 90) (off-label use only) and clopyralid (Dowshield) (off-label use only).

Several books and advisory booklets recommend the use of weed-wiper gloves for the spot-treatment of scattered weed species. However, at the time of writing (2003) there are not believed to be any current suppliers of such gloves in the UK.

Although weed-wiper gloves are not available, small hand-held weed-wipers, suitable for small-scale spot-treatment of scattered weeds are available (eg The Microwipe: [www.billericayfarmservices.com](http://www.billericayfarmservices.com)). These are usually lightweight, nylon or rope-wick applicators, with plastic handles which also function as the reservoir for the



Weedwiping birch saplings. Martin Davey/English Nature

herbicide. Various widths of wick (5-50 cm) and lengths of handle (80-120 cm) are available for different purposes.

Tractor-mounted or all-terrain vehicle-towed weed-wipers can be used, for example, for the larger-scale treatment of relatively tall weeds such as bracken, thistles and ragwort in grassland, or birch and gorse scrub on grassland and heathland. To be effective and to minimise risks to non-target species, most weed plants should be at least 10 cm taller than other vegetation. However, even in these circumstances, there will usually be several equally tall plants of non-target species that may be vulnerable – a factor that must be considered.

Another frequent problem is that several plants of the target species are, almost inevitably, below the level of the applicator and consequently remain after treatment. The greater the heterogeneity in height of the target species, the greater this problem becomes. Attempts to overcome this, by setting the applicator at a lower level, will increase the risks to non-target species and may (especially if woody plants are being treated) result in damage to application equipment. This in turn poses a great threat to non-target species if, for example, the boom reservoirs break. Care should be taken to avoid contact with suckers or low branches of susceptible tree and shrub species. Some weed-wipers are especially designed to follow at a set height the contours of uneven ground to improve the efficiency of wiping. Some manufacturers are now introducing automatic feedback control of herbicide flow to wipe heads to prevent dripping (Bacon *et al* 2001).

The travel speed for weed-wiper applications should be slow enough to ensure a thorough wiping of foliage in the range 4-10 km per hour. Two passes in opposite directions may be necessary for heavy weed infestations

**Note:** English Nature has produced a set of best practice weed-wipe notes available from English Nature's Enquiry Service. Email: [enquiries@english-nature.org.uk](mailto:enquiries@english-nature.org.uk).

### Hand-held sprayers

The most widely used type of hand-held sprayer is the knapsack sprayer, with a tank capacity of 15-20 litres. As the name suggests, these plastic tank sprayers are carried on the operator's back. They are pressurised by a hand- or battery-operated pump. The spray is deposited via a hand-held lance, which may be fitted with a hood or cone-shaped guard to minimise unintentional drift onto non-target species.

One alternative is the hand-held compression sprayer, which uses a supply of compressed air to maintain the required pressure during spraying.



Knapsack sprayer. John Bacon/English Nature

These types of sprayer are best suited to the application of herbicide spot-treatments around trees and shrubs, or to relatively small patches of weeds; to smaller-scale band spraying operations; and to larger-scale overall sprays on very rough or steep terrain, that is not readily accessible to machine-mounted sprayers.

- **CDA sprayers**

It is possible to apply herbicides to slightly larger areas by hand using Controlled Droplet Application (CDA) sprayers – which use much smaller quantities of water (10-30 litres per hectares instead of 100-200 litres per hectare). CDA sprayers are designed for low volume (LV) and ultra-low volume (ULV) pesticide applications which increase both pesticide and operator-efficiency. These sprayers incorporate a spinning disc, which produces a more even droplet size than traditional knapsack or tractor-mounted sprayers. CDA sprayers for herbicide applications produce large droplets, in the 200-300 micron range. The relatively large, even-sized droplets produced by CDA sprayers reduce the risks of inadvertent drift onto adjacent non-target plants. Larger droplets, and large quantities of water, may increase the losses to soil and water systems, as droplets 'bounce off' the foliage of target plants. Very small droplets, on the other hand, are more liable to drift away from target plants.

Hand-held sprayers may also be used for two types of specialist treatment method, for the eradication of unwanted trees or shrubs:

- **Basal bark sprays**

Sprays are applied in winter, to the base of relatively small (less than 15 cm stem diameter) trees or shrubs. It is frequently recommended that such sprays are applied in some sort of oil carrier (eg paraffin or diesel oil), to assist penetration through the bark.



- **Cut stump treatments**

Sprays can be applied to the newly exposed inner tissues of a recently felled broadleaved tree, to prevent sprouting and re-growth. To ensure effective uptake of the herbicide by the tree stump, it is recommended that sprays are applied almost immediately after felling. If this is not possible, it is probably better to apply a herbicide mixed with an oil carrier, rather than one in water. However, with herbicides in oil carriers, although timing is less important, it is vital that good coverage of the entire stump (including bark) and any exposed roots is ensured.

### **Tractor-mounted sprayers**

Most agricultural sprayers are mounted onto the three-point linkage of farm tractors, or towed on the tractor's tow-bar. Typically they have tanks with a capacity of 500-1000 litres and a boom width of 12-18 m. Agricultural contractors and many larger farms have bigger, self-propelled sprayers.

Some specialised All-Terrain Vehicles (ATVs) also have a three-point linkage facility to which small sprayers can be attached. The LOGIC sprayer is mounted on an ATV and does not require a three-point linkage. For bracken control, hand-held lances from an ATV sprayer are recommended for follow-up work.

These types of sprayer are best suited to large-scale, overall sprays across areas of low vegetation, such as that which is typical of arable fields and agricultural grassland. They are not suited to the application of spot treatments, for use among taller vegetation (especially woody vegetation) or across very steep or rough ground.

### **Granule applicators**

Herbicide granules (eg *Kerb Granules* or *Casoron G*) can be applied, on a small scale, using hand-held 'pepper-pot' type applicators. If larger areas require treatment, then various ATV or tractor-mounted granule applicators are available. Suitable types of tractor-mounted equipment include combined fertiliser/granule spreaders. For ease of application, it is important that granules are dry. It is, therefore, vital that granular herbicides are stored in dry conditions. It is also important that vegetation is dry at the time of treatment.

Some herbicides (eg ammonium sulphamate, *Amcide* or *Root-out*) that are usually applied as sprays, can also be applied as crystals to cut stumps or into 'frills' cut into the trunk of unwanted trees or shrubs.

### **Aerial applicators**

The least targeted spray application equipment is perhaps by helicopter or fixed wing planes. The accuracy of application clearly depends on the skill of the pilot to allow for turbulence effects of the aircraft through the air, along with the weather conditions. Of the herbicides listed for likely use on nature conservation sites in this Handbook only asulam (as *Asulox* or *IT Asulam*) has approval for use specifically on bracken on the following land types classes: **agricultural grassland, forestry, permanent pasture** and **rough upland intended for grazing**. Additionally *Asulox* has approval for **amenity grass** and *IT Asulam* for **amenity vegetation**.

Aerial operators have to comply with detailed rules including prior notification of at least 72 hours to English Nature, Scottish Natural Heritage or Countryside Council for Wales if application is to be made within 1500 metres of an SSSI, National Nature Reserve or certain other designated conservation sites. If the land to be treated is adjacent to or within 250 metres of water then the Environment Agency (England & Wales) or Scottish Environmental Protection Agency (Scotland) must be consulted at least 72 hours in advance of spraying. Notification is also required to water authorities, bee keepers, Environmental Health Operators, neighbours, hospitals, schools, etc. The full conditions are available from Defra and must be consulted. The Pesticide Safety Directorate Website lists approved products as *Annex B* in their *Guide to Pesticides*.

Reference must always be made to the product label for detailed conditions of use which must be complied with.

English Nature has produced a joint agency **Advisory Note**: Aerial spraying using asulam: *buffer zones* (June 1999). This is currently being updated (Autumn 2003).

### **3.2.2 Timing of application**

The timing of application is also a critical consideration. For example, foliar-acting herbicides may be most effective if applied to target species during a period of vigorous growth, in late spring or early summer; but this may also be the period when non-target species are most vulnerable to damage. The need to protect non-target species may require alternative, and often less effective and/or more expensive, options to be considered. Examples include late summer applications to tall weeds in early bud/flower stages by weed-wiper past the ideal susceptibility stage; winter-time herbicide applications to woody weed species; or stem-injection or cutting and treating stumps. Morning applications may be more effective than later day due to humidity effects.

### 3.3 Training and certification of advisers and spray operators

#### 3.3.1 Advisers

Under the requirements of COPR, PPP(BC)R and the statutory *Code of practice for suppliers of pesticides to agriculture, horticulture and forestry* (the Yellow Code), anyone who gives advice when selling or supplying an agricultural pesticide must have obtained a BASIS (British Agrochemical Standards Inspection Scheme) Certificate of Competence.

The BASIS Scheme is a system of self-regulation by the agrochemical industry. It is run by BASIS (Registration) Ltd, an independent organisation working with the UK Government to establish and maintain high standards for pesticide storage, distribution and use. BASIS-qualified pesticide advisers are listed on the BASIS Professional Register of Managers and Pest Technicians (PROMPT). Registered advisers, entitled to use the designatory letters MBPR (Member of the BASIS Professional Register) after their names, are bound by a Code of Ethics. The Code includes an obligation that:

“At all times, a member must ensure that the advice given, and any sales of product or services resulting there from, is in accordance with current legislation and in particular:

- has due regard to any environmental impact
- gives priority to the health and safety of those that purchase/use the products or services concerned.”

BASIS-registered advisers also have requirements to maintain their level of competence and to keep themselves fully up-to-date with technical developments. They must demonstrate this by obtaining a pre-determined number of continuing professional development points each year, through attendance at relevant conferences, publication of papers, etc, in order to remain on the BASIS Register.

BASIS certification courses for field sales and technical staff are run by various training agencies across the country. Courses cover specific areas of crop protection including agriculture, commercial horticulture, amenity horticulture, grassland and forage crops, aquatics and forestry. Advisers holding the full Certificate in Agriculture (Agric.), Commercial Horticulture (Hort.) or Field Vegetables (Veg.) do not require further certification to cover activities in amenity horticulture, aquatics, forestry, etc. However, those who hold the other specialist certificates are only qualified to advise on activities in that specified area.

Training courses usually run for between 15 and 25 days and cover aspects of pesticide use such as:

- plant growth and development and propagation systems;
- recognition and causes of plant disorders;
- recognition, biology and control of weeds;
- recognition, biology and control of pests;
- recognition, biology and control of diseases;
- composition, activity and persistence of pesticides and biological agents;
- application of pesticides; and
- safe use, handling, transport and storage of pesticides.

Completion of a training course is not an essential pre-requisite of the BASIS Certificate of Competence examination. However, all potential examinees should be sure that they have acquired sufficient technical knowledge and practical experience before applying.

A detailed booklet on BASIS training courses, *Training requirements for field sales and technical staff*, can be obtained from the BASIS office (email: [training.courses@basis-reg.co.uk](mailto:training.courses@basis-reg.co.uk)).

Further details and a full list of training agencies can be found at: [www.basis-reg.co.uk/TrainingCourses/TrainingCourse.htm](http://www.basis-reg.co.uk/TrainingCourses/TrainingCourse.htm)

#### 3.3.2 Spray operators

Contractors, and others applying agricultural pesticides to land or property not owned or occupied by them or their immediate employer, must also hold a recognised Certificate of Competence. This demonstrates that they are aware of all relevant legal requirements and have received adequate instruction in the safe and efficient use of pesticides. This legal requirement also applies to anyone supervising such a person in their work.

The only exceptions to this legal requirement are:

- any person born before 1 January 1965, or
- any person working under the “direct and personal supervision” of a certificate holder.

Appropriate spray operator courses are provided by the National Proficiency Tests Council (NPTC) in England and Wales, the Scottish Skills Testing Service and the Department of Agriculture and Rural Development in Northern Ireland.

The mandatory NPTC unit that must be successfully completed by all spray operators seeking a Certificate of Competence is the Foundation Module (PA01). NPTC then offer a number of optional specialist modules for the users of different types of spray equipment. For example, those most relevant to herbicide applications in nature conservation sites are:

- PA02A – Ground crop sprayer - boom type hydraulic nozzle.
- PA02F – Wick applicator – boom or frame type.
- PA04 – Granule applicator – mounted or trailed.
- PA05A – Boat-mounted applicator – hydraulic nozzle boom.
- PA06A – Hand-held applicators – hydraulic nozzle and/or rotary atomiser types.
- PA06AW – Hand-held applicators – application to water using hydraulic nozzle or rotary atomiser type sprayers.
- PA06B – Hand-held applicators – application to water using viscous gel applicators.
- PA06CW – Hand-held applicators – application to water using granule applicators.
- PA06D – Hand-held applicators – requiring minimal calibration.
- PA06C – Hand-held applicators – granule applicator.

There is also a specialist module for the aerial application of pesticides (PA07)

Further information on NPTC courses and qualifications can be obtained from their website: [www.nptc.org.uk](http://www.nptc.org.uk)

### 3.4 Health and safety

**All herbicides are potentially dangerous to spray operators and others that might be exposed to the concentrated chemical, diluted sprays or chemical residues.**

All pesticide users must assess the risks of pesticide applications before proceeding with treatment. A key part of this risk assessment is to ascertain the potential dangers to operators and other humans, including members of the public using nature conservation sites, during or after herbicide treatments. The product label always gives clear instructions on the appropriate protective clothing to be worn and any recommended use of mechanical means to minimise exposure.

**IMPORTANT: Product labels must always be read carefully and all statutory requirements complied with. This is a legal obligation.**

**Further information** about safety equipment and clothing for spray operators, including a selection chart and practical advice on maintaining and using personal protective equipment, can be found in the *Safety equipment handbook*, published in 2002 by the British Crop Protection Council (BCPC). Copies are available from BCPC Publication Sales (tel. 0118 934 2727 or can be ordered on-line at [www.bcpc.org/bookshop](http://www.bcpc.org/bookshop)).

Product labels also provide information about requirements for first aid or medical treatment in the event of accidental inhalation, ingestion or contamination of skin or eyes. Some herbicides (eg paraquat) are classed as poisons and are subject to particular requirements concerning storage and handling, under the terms of the Poisons Act 1972 and Poisons Rules 1982.

### 3.5 Environmental safety

Before any herbicide applications are made, landowners or managers must consider non-chemical alternatives.

To minimise the effects of herbicides on non-target species, it is important to minimise the possibility of spray drift away from the targeted area into vulnerable adjacent habitats. There are four main ways of achieving this:

1. Leave a suitably wide, unsprayed 'buffer zone'.
2. Avoid spraying in unsuitable weather conditions. Do not spray on days when the wind speed **exceeds** Force 2 (light breeze) on the Beaufort Scale or on very calm, warm days. Ideally, herbicide sprays should be applied when there is a light breeze (3.2-6.5 km per hour or 2-4 miles per hour: leaves rustle, wind felt on face), blowing away from any vulnerable areas.



3. Use nozzles that produce a medium-coarse droplet size – avoid fine sprays.
4. Keep spray nozzles as close as possible to the target plants (or area of soil), taking account of the minimum recommended nozzle height.

**Such precautions are particularly important to protect water bodies from herbicide contamination.**

Inadvertent, direct contact and spray drift represent greater threats to non-target plants than other forms of herbicide movement, although vapour drift can also occasionally have serious consequences (Breeze *et al* 1999).

As well as herbicide drift, and the potential dangers that this may pose to non-target species, anyone applying herbicides in semi-natural habitats must also take into account the possible consequences of vegetation destruction for the animal species that may feed, shelter, roost or nest there. Total destruction of an area of vegetation, or even the selective removal of certain plant species (which might alter the habitat structure or result in greatly increased growth rates of other species) may render that area unsuitable for some or all of its resident or foraging animal population. Nature conservation site managers need to consider the significance of this for the local fauna – in particular for any rare species – and weigh any potential losses against the benefits of weed control.

**Aquatic weeds**

The treatment of aquatic weeds requires special consideration. **Only products specifically approved for this purpose may be used. The Environment Agency (or SEPA in Scotland) must be notified in advance of any proposed application of pesticides to water.**

The application of herbicides to control submerged weeds and algae is normally recommended when weeds are growing most actively, in spring or early summer. However, this is when fish and aquatic fauna are breeding within the aquatic vegetation. On the other hand, delaying herbicide applications until late summer or autumn may lead to severe problems of deoxygenation, resulting from the microbial decomposition of large quantities of weed present in the water at this time.

For more detailed guidance on the use of herbicides for the control of aquatic weeds contact the IACR Centre for Aquatic Plant Management at Sonning, near Reading, Berkshire (email [capm@freeuk.com](mailto:capm@freeuk.com); or see [www.capm.org.uk](http://www.capm.org.uk)). You can obtain a copy of the MAFF/PSD publication *Guidelines for the use of herbicides on weeds in or near watercourses and lakes* (MAFF/PSD PB 2289) from the Department for the Environment, Food and Rural Affairs.

**3.6 Key references/Further reading**

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## 4. Herbicide options – efficacy and effects on non-target species

### 4.1 Approved herbicides

Only herbicides approved for use by Ministers can be legally used, the approval being issued by the Pesticides Safety Directorate (PSD) of the Department for Environment, Food and Rural Affairs (Defra). Furthermore, a herbicide must have either a full label approval or an appropriate off-label approval for use in any specific situation. Every site manager and spray operator has certain responsibilities that must be met before herbicides are applied. These responsibilities include:

1. To consider any possible alternatives to herbicide use.
2. If a herbicide is considered necessary, to ensure that environmental risks are fully considered and the necessary actions are taken to eliminate or minimise those risks. If there is more than one approved herbicide for the task in hand, select the one that is likely to pose the lowest risk to non-target flora and fauna.
3. To ensure that the product label (or the relevant Notice of Approval for specific off-label approvals) has been carefully read and understood. All safety instructions and information in the 'statutory box' must be complied with.

#### 4.1.1 Pesticide approvals system

##### PSD Crop Hierarchy

PSD have recently introduced a rationalised system for the use of crop names and crop groups in Notices of Approval. Since January 2001 this new PSD 'Crop Hierarchy' has been used for all **new** product approvals - except for 'off-labels' which are currently outside of these arrangements.

The Crop Hierarchy is arranged in four levels:

- **Top level categories** (three categories):
  - All edible crops.
  - All non-edible crops.
  - Non-crop production.
- **Parent groups** (for some Top level categories only).
- **Primary groups** (26 groups – see Figure 2).
- **Basic crops or situations** (see Table 2).

**New** approvals are given at one of three levels:

- basic crops and situations (eg **permanent grassland** or **amenity vegetation**),
- top level categories (eg **non-crop production**), or
- 'all situations' – which encompasses all three top level categories and every subsidiary group within them.

Approvals are not given at the parent group or primary group levels. So, for example, approvals would not be given for **agricultural herbage** or **industrial** and **amenity areas**.

The eleven basic crops and situations within these four groups that are considered to have the greatest relevance are listed in Table 2. This table also gives the official definitions of each relevant basic crop or situation.

The crop hierarchy includes definitions for all basic crops and situations. A full list can be found on the PSD website ([www.pesticides.gov.uk/general/crophierarchy](http://www.pesticides.gov.uk/general/crophierarchy)).

Approvals also frequently include a list of qualifiers to modify these basic crops or situations to cover more restrictive situations.

PSD have checked all existing extant approvals against the new hierarchy, but it is important to note that new definitions (eg those quoted in Table 2) do not necessarily apply to terms used in Notices of Approval issued before the introduction of the Crop Hierarchy.

**Figure 2: The PSD Crop Hierarchy: top level categories and primary groups.**  
 Primary groups of greatest relevance to nature conservation sites are shown in **bold**.

All edible crops	All non-edible crops	Non-crop production
Cereals Oil seeds Vegetable brassicas Top fruit Legumes Soft fruit Leafy vegetables Stem vegetables Bulb vegetables Fruiting vegetables Root and tuber crops Herbs <b>Agricultural herbage</b> Food products Edible fungi Apiculture Other crops	Green cover <b>Forestry</b> Industrial crops Ornamentals	Indoors Amateur products <b>Aquatic area</b> <b>Industrial and amenity areas</b> Other situations

**Table 2: Basic crops and situations and associated definitions most relevant to nature conservation sites.**

Primary group/ Parent group	Basic crop or situation	Definition
Agricultural herbage	Rotational grass	Short-term grass crops (leys) grown on land that is likely to be growing different crops in future years. Normally short-term leys, intensively managed, that are under grass for one to three years and other arable crop in other years. (May include clover.)
	Permanent grassland	Grazed areas that are intended to be permanent in nature. This includes permanent pasture and marginal land such as moorland that can be grazed; can be less intensively managed and floristically rich.
Forestry	Forest	Groups of trees being grown in their final positions, eg after planting out from a forest nursery or from natural regeneration, colonisation or coppicing. Covers all woodland grown for whatever objective, including commercial timber production, amenity and recreation, conservation or landscaping, ancient traditional coppice and farm forestry. This includes restocking of established woodland and new planting on both improved and unimproved land.
	Farm forestry	Groups of trees established on arable land or improved grassland, including those planted for short rotation coppicing. Includes mature hedgerows around arable fields.
	Cut log	Any felled timber.

**Table 2: Cont...**

Primary group/ Parent group	Basic crop or situation	Definition
Aquatic area	Enclosed waters	Any natural or artificial body of water that does not drain to a watercourse.
	Intertidal zones of estuary	The area between the low and high water marks of a river estuary.
	Land immediately adjacent to aquatic area	The bank of any watercourse or body of water.
	Open waters	Any natural or artificial body of water that drains to a watercourse or is used as a reservoir for domestic water supplies.
Industrial and amenity areas	Amenity grassland	Areas of semi-natural or planted grassland subject to minimal management. Includes areas that may be accessed by the public such as golf fairways. May be floristically rich and irregularly managed so that plants may flower and set seed.
	Amenity vegetation	Any areas of semi-natural or ornamental vegetation, including trees, or bare soil around ornamental plants or intended for ornamental planting. Includes areas of grassland or turf and areas to which the public have access. Does NOT include hedgerows around arable fields.

Any terms used in older approvals should be clearly explained on the product label. The PSD website has a useful 'Crop/Situation Conversion Form' which indicates which old crops/situations relate to which new crop hierarchy crops/situations. Some relevant examples include:

Old	New
Agricultural grassland	Permanent grassland or rotational grass.
Aquatic situation	Enclosed waters or open waters or land immediately adjacent to aquatic areas.
Hedge*	Amenity vegetation or ornamental garden plants.
Ley	Permanent grassland or rotational grass.
Non-crop areas	Areas not intended to bear vegetation or green cover on land temporarily removed from production or natural surfaces not intended to bear vegetation.

**\*Note**, however, that PSD definitions clearly state that mature hedgerows around arable fields are classed as 'farm forestry', not 'amenity vegetation' (see Table 2).

The list in Table 2 does not include all parent groups and basic crops or situations for these four primary groups. Others that were not considered relevant to this publication were excluded. The additional basic crops and situations, listed by primary group, are:

- **Agricultural herbage**
  - Vetch.
  - Lucerne.
  - Sainfoin.
  - Red clover (includes grass clover mixtures where red clover forms, or will form a majority of the biomass).
  - White clover (includes grass clover mixtures where white clover forms, or will form a majority of the biomass).
- **Forestry**
  - Forest nursery.
- **Aquatic area**
  - Aquarium.
- **Industrial and amenity areas (plant free areas)**
  - Natural surfaces not intended to bear vegetation.
  - Permeable surfaces overlying soil.
  - Hard surfaces.
  - Wood surfaces.

A few of the other primary groups in Figure 2 may have some relevance to nature conservation. One example is 'green cover', which includes a single basic crop or situation – green cover on land temporarily removed from production. The definition for this makes it clear that it includes natural regeneration and sown grass covers on short-term set-aside.

New basic crops or situations will be added by PSD, as the need arises.

Full, up-to-date lists of the complete Crop Hierarchy can be viewed on the PSD website at [www.pesticides.gov.uk/general/CropHierarchy/Introduction.htm](http://www.pesticides.gov.uk/general/CropHierarchy/Introduction.htm) or obtained from the PSD Information Section, tel. 01904 455775.

**Heathland and moorland.** There are no specific categories for heathland or moorland. However, all heath and moorland habitats should be covered within the definition of **amenity vegetation** and many will also be included within the definitions of **permanent grassland** or **amenity grassland**.

#### 4.1.2 Relevant approvals

For the purposes of this Handbook, herbicides considered to have relevant approvals for use in nature conservation sites include **those currently approved for use in any of the 11 basic crops and situations listed in Table 2** (within the 'crop hierarchy' categories agricultural herbage, forestry, aquatic areas, industrial and amenity areas) or **one of the following situations**, which are still applicable for many older herbicides:

- **Amenity grassland** (includes semi-natural grassland).
- **Amenity trees and shrubs.**
- **Amenity vegetation** (includes semi-natural areas 'herbaceous plants, trees and shrubs').
- **Areas of water/aquatic situations/weeds in or near water.**
- **Forest** (covers all woodland grown for any purpose, including timber production, amenity and recreation, conservation, ancient traditional coppice, etc).

#### Current herbicide approvals relevant to nature conservation sites

Information on herbicides that might be valuable for nature conservation site managers is summarised in Tables 3 and 4.

**Table 3: Target species and possible herbicides for their control** lists possible herbicides for use against some of the most frequently encountered 'weed' species requiring control in nature conservation sites. It includes only those herbicides with approvals for use in situations considered relevant to nature conservation sites (in the broader sense). Table 3 also includes short notes on relevant situations, application methods and timings for each listed herbicide.

**Table 4: Key herbicides for use in nature conservation sites** lists 38 herbicides and mixtures, along with the names of most of the products containing these chemicals which have relevant current approvals. Table 4 also lists the manufacturer/distributor and formulation (a.i. conc.) for each listed product. It includes notes on the target plants/plant groups for which it is recommended, the relevant approved uses and, where relevant, the stock withholding period (ie the minimum period for which livestock must be removed after herbicide treatment).

Most current approvals still relate to old categories for fields of use. Listed below are examples of products approved for uses relevant to particular situations in which herbicides might be used in nature conservation sites. Further information on approved situations for use and weeds that these herbicides might be used to control is given in Tables 3 and 4.►►

### Amenity vegetation

Herbicide products with full label approval for use on **amenity vegetation** include *CDA Vanquish*, *Rival* and *Roundup Pro Biactive* (glyphosate). The asulam product *I T Asulam* is approved for use against bracken in amenity vegetation.

Other glyphosate products are approved for weed control in **amenity areas** (eg *Barclay Gallup Amenity*, *Barclay Gallup Biograde Amenity* and *Roundup Pro Biactive*) or **amenity grass** (eg *Roundup Pro Biactive* and *Spasor*). A small number of glyphosate products (eg *Rival* and *Roundup Pro Biactive*) also have a specific label approval for application to amenity areas and amenity grass using a weed-wiper. Both *I T Asulam* and *Asulox* (another asulam product) are approved for the control of docks in **amenity grass (not fine turf)**. *Grazon 90* (clopyralid + triclopyr); *Depitox*, *MSS 2,4-D Amine* and *Ragox* (2,4-D); *Mazide Selective* (dicamba + maleic hydrazide + MCPA); *Headland Relay P*, *Hycamba Plus*, *Hysward-P* and *Pasturol Plus* (dicamba + MCPA + mecoprop-P) are all also approved for use in **amenity grass**.

### Grassland

The many products with full label approval for weed control in grassland, for example **'established grassland'** or **'permanent pasture'** include *I T Asulam* and *Asulox* (asulam); *Dow Shield* (clopyralid); *Grazon 90*, *Thistlex* (clopyralid + triclopyr); *Agricorn D II*, *Depitox*, *Dioweed 50*, *MSS 2,4-D Amine* (2,4-D); *Broadsword* and *Nufarm Nu-Shot* (2,4-D + dicamba + triclopyr); *Headland Polo* (2,4-D + MCPA), *Sydex* (2,4-D + mecoprop-P), *Atladox-HI* (2,4-D + picloram), *Cadence* (dicamba); *Banlene Super*, *Headland Relay P*, *Mircam Plus* and *Pasturol Plus* (dicamba + MCPA + mecoprop-P), *Condox*, *Foundation* and *Hygrass-P* (dicamba + mecoprop-P); *Barclay Keeper 500 FL* (ethofumesate); *Starane 2* (fluroxypyr); *Agroxone*, *Headland Spear* and *MSS MCPA 50* (MCPA); *Duplosan KV*, *Landgold Mecoprop-P 600* and *Optica* (mecoprop-P); *Prospect* (thifensulfuron-methyl) and *Garlon 2* (triclopyr); (Whitehead 2003).

### Amenity trees and shrubs

Herbicide products with full label approval for use in **amenity trees and shrubs** include *Barclay Gallup Amenity*, *Hilite*, *Rival* and *Roundup Pro Biactive* (glyphosate). A small number of glyphosate products (*Rival*, *Roundup Pro Biactive* and *Spasor*) also have a specific label approval

for application in **amenity trees and shrubs** using a weed-wiper. The growth regulators *Mazide 25* and *Regulox K* (maleic hydrazide) are also approved for use as a suppressant of tree and shrub suckers.

### Areas of water/aquatic situations/weeds in or near water

Herbicide products with full label approval for use in **aquatic situations** or in other situations in and around watercourses include *Asulox* (asulam); *Dormone*, *MSS 2,4-D Amine* and *Ragox* (2,4-D); *Casoron G*, *Luxan Dichlobenil Granules*, *Sierraron G* (dichlobenil); *Krenite* (fosamine-ammonium)\*; *Barclay Barbarian*, *Barclay Gallup Amenity*, *Barclay Gallup Biograde Amenity*, *Buggy SG*, *Glyfos ProActive*, *MSS Glyfield*, *Roundup Pro Biactive*, *Spasor* and *Spasor Biactive* (glyphosate); *Regulox K* (maleic hydrazide); and *Clarosan* (terbutryn)\*.

\*All on-label approvals for terbutryn, fosamine-ammonium, imazapyr and dichlorprop are to be withdrawn from July 2003.

**Two diquat products (*Midstream* and *Reglone*) were also approved for use in water, and widely used until an EC review of all plant protection active substances concluded that all uses of diquat for aquatic weed control should be revoked.**

Consequently, these products must no longer be applied to water. This will make the control of some aquatic weeds more difficult. For example, most recommendations (eg from the Centre for Aquatic Plant Management, the University of Liverpool's Invasive Alien Species Project and NERC-CEH Dorset) suggest the use of *Midstream* for the treatment of submerged and emergent New Zealand pigmyweed plants in water, with glyphosate used to treat bankside plants (or dry, emergent plants in dense stands). Similarly, the same sources have recommended the use of *Reglone* for the control of floating pennywort and parrot's feather, although (unlike New Zealand pigmyweed) both of these species may be partially controlled using mechanical methods. For parrot's feather, dichlobenil applications in April offer a suitable alternative herbicide treatment.

### Forestry

Herbicide products with full label approval for forestry use include *Amcide* and *Root-Out* (ammonium sulphamate); *Asulox* (asulam); *Laser* (cycloxydim); *Dicotox Extra*, *Easel* (2,4-D); *Broadsword* and *Nufarm Nu-Shot* (2,4-D + dicamba + triclopyr); *Barbarian*, *Rival* and *Roundup Pro Biactive* (glyphosate); *Flexidor 125* (isoxaben); *Butisan S* (metazachlor); *Falcon* (propaquizafop); *Kerb 50 W* (propyzamide); *Garlon 4* and *Timbrel* (triclopyr); (Whitehead 2003).



The current label for *Alpha Simazine 50 SC* (simazine) states that it has approval for use in 'forestry plantations' rather than the more generic 'forestry'. This may make its use in semi-natural woodland of questionable legality.

*Arsenal 50* (imazapyr) is approved for forestry, but only for bracken or total vegetation control in site preparation. All approvals for imazapyr are to be withdrawn from July 2003.

Subject to certain specified conditions, current Government off-label approvals also permit, in **farm forestry** (established on land which was previously under arable cultivation or improved grassland - as defined by the Forestry Authority for the purposes of the Woodland Grant Scheme), and improved brownfield sites:

- Any herbicide which has full (or provisional) approval for use on cereals to be used in the first five years of establishment.

This long-term off-label arrangement potentially increases the weed control options for landowners and site managers establishing new native woodlands on former agricultural sites. At present, however, only a small number of the many 'cereal' herbicides have been properly evaluated for safety and efficacy in young farm woodlands. Users should be aware that there is a risk that pesticides used under an off-label approval may not be as effective.

Elsewhere in Europe, woodland managers are often much more tightly restricted in their choice of herbicides. Managers in the UK might similarly expect that environmental pressures may reduce their options for herbicide usage in the years ahead.

**Table 3: Target species and possible herbicides for their control.**

(\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Alga <i>Enteromorpha</i> spp.	Areas of water.	Terbutryn ( <i>Clarosan</i> )*	Granules applied to water surface in static or sluggish water-bodies only. Always consult EA, LRPA or SEPA before use.	Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	46, 105
Ash <i>Fraxinus excelsior</i>	See woody weeds.				
Aspen <i>Populus tremula</i>	See woody weeds.				
Birches <i>Betula</i> spp.	See woody weeds.				
Blackthorn <i>Prunus spinosa</i>	See woody weeds.				
Bracken <i>Pteridium aquilinum</i>	Forestry, permanent pasture, rough grazing.	Asulam ( <i>Asulox</i> , / <i>T Asulam</i> )	Foliar spray. Do not graze or cut in period before or after spraying (leave for <b>at least 14</b> days after treatment). May be applied through CDA equipment. Approved for use near surface waters.	Jul-Aug when fronds fully expanded but not senescent. Not during drought or in hot, dry conditions. In pastures, not before hay is cut. Repeat to kill surviving plants after recovery to full green fronds (probably in following year).	29, 53
	Non-crop areas.	( <i>Asulox</i> )	As above.	As above.	
	Amenity vegetation.	(/ <i>T Asulam</i> )	As above.	As above.	
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Foliar spray or weed-wipe.	Late spring/summer – at full frond expansion.	36–41, 83

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Bracken (Cont)	Non-crop areas, fence-lines, forestry (site prep.), railway tracks.	Imazapyr (Arsenal, Arsenal 50)*	Foliar spray.	Any time of year, when weeds actively growing.	41, 87
	Established leys & permanent pasture.	Dicamba (Cadence)	Foliar spray.	When bracken is actively growing.	32–33, 63
	Non-crop grass, non-crop areas.	Picloram (Tordon 22K)	Foliar spray.	2–4 weeks before frond emergence.	45, 101
	Forestry.	Ammonium sulphamate (Amcide or Root-Out)	Sprays to low scrub or herbaceous spp.	Apr–Sept in dry weather.	29, 51
Bramble <i>Rubus</i> subg. <i>Rubus</i>	Amenity grass, established grassland.	Clopyralid + triclopyr (Grazon 90)	Foliar spray or weed-wiper (established grass only, off-label).	June–Aug. Apply to actively growing weeds.	29–30, 57
	Amenity grass, established grassland.	2,4-D (eg Depitox)	Foliar spray. Do not mow amenity grass within two days before or one day after spraying. Do not mow or graze other grassland for at least 10 days after spraying.	Best results if applied to seedlings/young plants, when growing actively. Not during rain or when rain is imminent.	30–32, 61
	Grassland.	(MSS 2,4-D Amine)	As above.	As above.	
	Apple & pear orchards.	(Barclay Haybob II, Depitox, Luxan 2,4-D)	As above.	As above.	
	Conifer plantations & forestry.	(Dicotox Extra, Easel)	As above.	As above.	

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Bramble (Cont)	Water or waterside areas.	(Dormone or Ragox)	As above. Always consult EA, LRPA or SEPA before use in or near water.	As above.	30–32, 61
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr (Broadsword or Nufarm Nu-Shot)	Foliar spray.		
	Forestry, non-crop areas, waterside areas, conifer plantations (off-label).	Fosamine-ammonium (Krenite)*	Overall foliar spray (with wetter). Always consult EA, LRPA or SEPA before use in or near water.	Aug-Oct.	36, 79
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fencelines, road verges.	Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wipe.	At or near flowering, but before onset of senescence.	36–41, 83
	Established grassland, non-crop areas.	Triclopyr (Garlon 2)	Foliar spray (in water), overall or spot-treatment.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
	Forestry.	(Garlon 4 or Timbrel)	As above.	As above.	46, 107
Broom <i>Cytisus scoparius</i>	See woody weeds.				
Buckthorn, sea <i>Hippophae rhamnoides</i>	See woody weeds.				
Buttercups <i>Ranunculus</i> spp.	Aquatic situations.	Dichlobenil (eg Casoron G, Sierraron G)	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.	Early spring.	33–34, 65
	Areas of water.	Terbutryn (Clarasan)*	Granules applied to water surface in static or sluggish water-bodies only. Always consult EA, LRPA or SEPA before use.	Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	46, 105

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Butterfly-bush <i>Buddleja davidii</i>	See woody weeds.				
Cord-grass, common <i>Spartina anglica</i>	Amenity grass & vegetation, aquatic situations.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Foliar spray or weed-wipe. Always consult EA, LRPA or SEPA before use in or near water.	Spring/summer, when grass actively growing. Grass with at least 4-5 new leaves & at least 10 cm tall.	36–41, 83
Cow parsley <i>Anthriscus sylvestris</i>	Amenity grass, established grassland.	2,4-D (eg <i>Depitox</i> )	Foliar spray. Do not mow amenity grass within two days before or one day after spraying. Do not mow or graze other grassland for at least 10 days after spraying.	Best results if applied to seedlings/young plants, when growing actively. Not during rain or when rain is imminent.	30–32, 61
	Grassland.	(MSS 2,4-D Amine)	As above.	As above.	30–32, 61
	Apple & pear orchards.	(Barclay Haybob II, Depitox, Luxan 2,4-D)	As above.	As above.	
	Conifer plantations & forestry.	(Dicotex Extra, Easel)	As above.	As above.	
	Water or waterside areas.	(Dormone or Ragox)	As above. Always consult EA, LRPA or SEPA before use in or near water.	As above.	
	Non-crop grass, non-crop areas.	Picloram (Tordon 22K)	Foliar spray.	Any time of year.	
Docks <i>Rumex</i> spp.	Amenity grass (not fine turf), apple & pear orchards, permanent pasture.	Asulam (Asulox, I T Asulam)	Foliar spray (directed in fruit crops). May be applied through CDA equipment. Approved for use near surface waters.	Spring/early summer, when docks in full leaf but before flower stem emergence. Not during drought or in hot, dry conditions. In pastures, not before hay is cut.	29, 53



**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Docks (Cont)	Road verges, waste ground.	(I T Asulam)	As above.	As above.	29, 53
	Established grassland.	Clopyralid + fluroxypyr + triclopyr (Pastor)	Foliar spray.	Spring or autumn. Apply to actively growing weeds, which must have sufficient leaf area for herbicide uptake. Maximum of one treatment per year (or two at half rate). Follow-up treatment, in next year, may be necessary.	29–30, 57
	Amenity grass, established grassland.	Clopyralid + triclopyr (Grazon 90)	Foliar spray or weed-wiper (established grass only, off-label).	Spring. Apply to actively growing weeds, at rosette stage.	29–30, 57
	Amenity grass, established grassland.	2,4-D (eg Depitox)	Foliar spray. Do not mow amenity grass within two days before or one day after spraying. Do not mow or graze other grassland for at least 10 days after spraying.	Best results if applied to seedlings/young plants, when growing actively. Not during rain or when rain is imminent.	30–32, 61
	Grassland.	(MSS 2,4-D Amine)	As above.	As above.	
	Apple & pear orchards.	(Barclay Haybob II, Depitox, Luxan 2,4-D)	As above.	As above.	
	Conifer plantations & forestry.	(Dicotox Extra, Easel)	As above.	As above.	
	Water or waterside areas.	(Dormone or Ragox)	As above. Always consult EA, LRPA or SEPA before use in or near water.	As above.	
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr (Broadsword or Nufarm Nu-Shot)	Foliar spray, weed-wipe (1/3 dilution) or rope-wick applicator (1/8 dilution).		30–32, 61

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Docks (Cont)	Established leys & permanent pasture.	Dicamba (Cadence)	Foliar sprays (spot-treatment with hand-held sprayer). Large, well established plants may require second treatment in following year (only one full dose allowed per year).	When weeds are actively growing, before flowering shoots appear.	32–33, 63
	Established grassland, apple & pear orchards.	Fluroxypyr (Starane 2)	Foliar spray.	Best results achieved under good growing conditions. Rainfast in 1 hour. Not if frost is imminent. Maximum of one treatment per year.	35, 77
	Amenity grass.	Fluroxypyr + triclopyr (Evade)	Foliar spray, overall or spot-treatment. Avoid contact with non-target plants.	Spring or autumn. Docks at rosette stage, up to 20 cm high or across. Allow 2-3 weeks after cutting or grazing before spraying. Not during drought, or in very hot or very cold weather.	35, 77
	Established grassland.	(Doxstar)	As above.	As above.	
	Fallows, forestry, grassland (sward destruction), headlands (uncropped), land temporarily removed from production, non-crop farm areas, orchards.	Glufosinate-ammonium (Challenge)	Foliar spray, overall or spot-treatment. Deep-rooted plants may require follow-up treatment..	1 Mar to 30 Sept. Best results when weeds growing actively; in warm, moist conditions (but do not spray wet foliage, or if rain likely within 6 hours). Allow re-growth of heavily grazed vegetation.	36, 81
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fencelines, road verges.	Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wipe.	At or near flowering, but before onset of senescence.	36–41, 83
	Established grassland, amenity grass, road verges.	MCPA (eg Headland Spear, MSS MCPA 50)	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	41–43, 91

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Docks (Cont) <i>Rumex</i> spp.	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon</i> 2)	Foliar spray, overall or spot-treatment.	Spring or summer (weeds in active growth). Not when very hot or during drought.	46, 107
	Forestry.	( <i>Garlon</i> 4 or <i>Timbrel</i> )	As above.	As above.	
Dogwood <i>Cornus sanguinea</i>	See woody weeds.				
Duckweeds <i>Lemna</i> spp.	Aquatic situations.	Dichlobenil (eg <i>Casoron</i> G, <i>Sierraron</i> G)	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.	Early spring.	33–34, 65
	Aquatic situations.	Glyphosate (eg <i>Rival</i> or <i>Roundup</i> <i>Pro Biactive</i> )	Maximum permitted concentration in treated water 0.2 ppm. Always consult EA, LRPA or SEPA before use.		36–41, 83
	Areas of water.	Terbutryn ( <i>Clarasan</i> )*	Granules to water surface in static or sluggish water-bodies only. Always consult EA, LRPA or SEPA before use.	Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	46, 105
<i>Elder Sambucus nigra</i>	See woody weeds.				
Foxglove <i>Digitalis purpurea</i>	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup</i> <i>Pro Biactive</i> )	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wipe.	At or near flowering, but before onset of senescence.	36–41, 83
<i>Gorse Ulex</i> spp.	See woody weeds.				
Grasses - annual & perennial	Apple orchards, farm woodlands, forestry.	Propyzamide ( <i>Kerb</i> 50 W)	Spray (active via root uptake).	Best results if applied in winter. Rain required after application, if soil is dry. Maximum of one application per year. Repeat application may be necessary in following winter for heavy couch infestations.	45–46, 103

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Hawthorn <i>Crataegus monogyna</i>	See woody weeds.				
Hazel <i>Corylus avellana</i>	See woody weeds.				
Hogweed, giant <i>Heracleum mantegazzianum</i>	Amenity grass, established grassland.  Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.  <b>Total vegetation control in</b> farm buildings/yards, fence-lines, forestry (site preparation), industrial sites, non-crop areas, railway tracks.	Clopyralid + triclopyr (Grazon 90)  Glyphosate (eg Rival or Roundup Pro Biactive)  Imazapyr (Arsenal 50, Parade)*	Foliar spray or weed-wiper (established grass only, off-label).  Foliar sprays (spot-treatment with hand-held sprayer) or weed-wiper.  Foliar spray (directed), carefully avoiding foliage and roots/root zones of non-target plants. Gives long-term residual control. Must not be used as site preparation treatment for broad-leaved trees. May be applied through CDA equipment.	Apply to actively growing weeds.  At or near flowering, but before onset of senescence.  Any time of year. Can be applied before weed emergence, but best results when applied to actively growing weeds.	29–30, 57  36–41, 83  41, 87
	Established grassland, non-crop areas.  Forestry.	Triclopyr (Garlon 2)  (Garlon 4 or Timbrel)	Foliar spray, overall or spot-treatment.  As above.	Spring or summer (weeds in active growth). Not when very hot or during drought.  As above.	46, 107
Horsetail, field <i>Equisetum arvense</i>	Grassland.  Conifer plantations & forestry.	2,4-D (MSS 2,4-D Amine)  (Dicotex Extra, Easel) (Dormone)	Foliar spray.  As above.	Seedlings/young plants, when growing actively.  As above.	30–32, 61

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Horsetail, field (Cont)	Water or waterside.	(Dormone)	As above. Always consult EA, LRPA or SEPA before use in or near water.	As above.	30–32, 61
	Established grassland, amenity grass, road verges.	MCPA (eg Headland Spear, MSS MCPA 50)	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	41–43, 91
	Forestry.	Propyzamide (eg Headland Judo, Kerb Pro Flo, Menace 80 EDF)	Spray (active via root uptake).	Best results if applied in winter. Rain required after application, if soil is dry. Maximum of one application per year.	45–46, 103
Indian (Himalayan) balsam <i>Impatiens glandulifera</i>	Amenity grass, established grassland.	2,4-D (eg Depitox)	Foliar spray. Do not mow amenity grass within two days before or one day after spraying. Do not mow or graze other grassland for at least 10 days after spraying.	Best results if applied to seedlings/young plants, when growing actively. Not during rain or when rain is imminent.	30–32, 61
	Grassland.	(MSS 2,4-D Amine)	As above.	As above.	
	Apple & pear orchards.	(Barclay Haybob II, Depitox, Luxan 2,4-D)	As above.	As above.	
	Conifer plantations & forestry.	(Dicotox Extra, Easel)	As above.	As above.	
	Water or waterside areas.	(Dormone or Ragox)	As above. Always consult EA, LRPA or SEPA before use in or near water.	As above.	
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges, aquatic situations.	Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wipe. Always consult EA, LRPA or SEPA before use in or near water.	At or near flowering, but before onset of senescence.	36–41, 83



**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Japanese knotweed <i>Fallopia japonica</i>	Forestry, trees & shrubs.	Ammonium sulphamate (Amcide or Root-Out)	Sprays to low vegetation.	Apr-Sept in dry weather.	29, 51
	Established leys & permanent pasture.	Dicamba (Cadence)	Foliar sprays (spot-treatment with hand-held sprayer). Large, well-established plants may require second treatment in following year (only one full dose allowed per year).	When weeds are actively growing, before flowering shoots appear.	32–33, 63
	Grassland.	2,4-D (MSS 2,4-D Amine)	Foliar spray.	Seedlings/young plants, when growing actively.	30–32, 61
	Conifer plantations & forestry.	(Dicotox Extra, Easel)	As above.	As above.	
	Water or waterside.	(Dormone)	As above.	As above.	
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr (Broadsword or Nufarm Nu-Shot)	Foliar spray, weed-wipe (1/3 dilution) or rope-wick applicator (1/8 dilution).		30–32, 61
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges, aquatic situations.	Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wiper. For tall plants, cut then spray re-growth. Always consult EA, LRPA or SEPA before use in or near water.	At or near flowering, but before onset of senescence.	36–41, 83
	Non-crop areas, farm buildings /yards, fence-lines, forestry (site prep.), railway tracks.	Imazapyr (Arsenal, Arsenal 50)*	Foliar spray.	Any time of year, when weeds actively growing.	41, 87
	Non-crop grass, non-crop areas.	Picloram (Tordon 22K)	Foliar spray.	Any time of year, but best results in late winter/early spring.	45, 101

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Japanese knotweed (Cont)	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon 2</i> )	Foliar spray, overall or spot-treatment.	Spring or summer (weeds in active growth). Not when very hot or during drought..	46, 107
	Forestry.	( <i>Garlon 4</i> or <i>Timbrel</i> )	As above.	As above.	
Nettle, common <i>Urtica dioica</i>	Fallows, forestry, grassland (sward destruction), headlands (uncropped), land temporarily removed from production, non-crop farm areas, orchards.	Glufosinate-ammonium (Challenge)	Foliar spray, overall or spot-treatment. Deep-rooted plants may require follow-up treatment.	1 Mar to 30 Sept. Best results when weeds growing actively; in warm, moist conditions (but do not spray wet foliage, or if rain likely within 6 hours). Allow re-growth of heavily grazed vegetation.	36, 81
	Established grassland, amenity grass, road verges.	MCPA (eg <i>Headland Spear</i> , <i>MSS MCPA 50</i> )	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	
	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon 2</i> )	Foliar spray, overall or spot-treatment.	Spring or summer (weeds in active growth). Not when very hot or during drought.	46, 107
	Forestry.	( <i>Garlon 4</i> or <i>Timbrel</i> )	As above.	As above.	
	Grassland.	2,4-D ( <i>MSS 2,4-D Amine</i> )	Foliar spray.	Seedlings/young plants, when growing actively.	30–32, 61
	Conifer plantations & forestry.	( <i>Dicotox Extra</i> , <i>Easel</i> )	As above.	As above.	
Oaks <i>Quercus</i> spp.	Water or waterside.	( <i>Dormone</i> )	As above.	As above.	
	See woody weeds.				

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Parrot's-feather <i>Myriophyllum aquaticum</i>	Aquatic situations.  Areas of water.	Dichlobenil (eg Casoron G, Sierraron G)  Terbutryn (Clarasan)*	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.  Granules applied to water surface in static or sluggish water-bodies only. Always consult EA, LRPA or SEPA before use.	Early spring.  Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	33–34, 65  46, 105
Pennywort, floating <i>Hydrocotyle ranunculoides</i>	Water or waterside.  Aquatic situations.	2,4-D amine (Dormone)  (MSS 2,4-D Amine)	Foliar spray. Always consult EA, LRPA or SEPA before use.  As above.	May-Sept, when weeds in active growth.  As above.	30–32, 61
Pigmyweed, New Zealand <i>Crassula helmsii</i>	Aquatic situations.  Aquatic weeds.  Aquatic situations.	Dichlobenil (eg Casoron G, Sierraron G)  Diquat (Midstream or Reglone)  Glyphosate (eg Rival or Roundup Pro Biactive)	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.  Previously the recommended treatment (Midstream), but <b>all approvals for aquatic use withdrawn in 2002</b> .  Preferred treatment for emergent or bankside weeds. Maximum permitted concentration in treated water 0.2 ppm. Always consult EA, LRPA or SEPA before use.	Early spring.      Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	33–34, 65  34, 71  36–41, 83  46, 105

**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Pondweed, broad-leaved <i>Potamogeton natans</i>	Aquatic situations.	Dichlobenil (eg <i>Casoron G</i> , <i>Sierraron G</i> )	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.	Early spring.	33–34, 65
	Aquatic situations.	Glyphosate (eg <i>Rival</i> or <i>Roundup</i> <i>Pro Biactive</i> )	Maximum permitted concentration in treated water 0.2 ppm. Always consult EA, LRPA or SEPA before use.		36–41, 83
Purple moor-grass <i>Molinia caerulea</i>	Farm forestry, field margins.	Fluazifop-P-butyl	Foliar spray (with adjuvant), but not through CDA, hand-held sprayer or by air.	When weeds actively growing. Warm air temperature & damp soils preferred.	35, 75
	Non-crop areas, fence-lines, forestry (site prep.), railway tracks.	Imazapyr ( <i>Arsenal</i> , <i>Arsenal 50</i> )*	Foliar spray.	Any time of year, when weeds actively growing.	41, 87
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, roadverges.	Glyphosate (eg <i>Rival</i> or <i>Roundup</i> <i>Pro Biactive</i> )	Foliar spray or weed-wiper.	Spring/summer, when grass actively growing. Grass with at least 4-5 new leaves & at least 10 cm tall.	36–41, 83
Ragwort, common <i>Senecio jacobaea</i>	Grassland.	2,4-D ( <i>MSS 2,4-D Amine</i> )	Foliar spray.	Seedlings/young plants, when growing actively.	30–32, 61
	Conifer plantations & forestry.	( <i>Dicotox Extra</i> , <i>Easel</i> )	As above.	As above.	
	Water or waterside.	( <i>Dormone</i> )	As above.	As above.	
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr ( <i>Broadsword</i> or <i>Nufarm Nu-Shot</i> )	Foliar spray, weed-wipe (1/3 dilution) or rope-wick applicator (1/8 dilution).		30–32, 61
		Clopyralid ( <i>Dow Shield</i> )	Foliar sprays, weed-wiper (off-label).	Apply to young, actively growing seedlings. Do not apply when vegetation is damp or rain expected within 6 hours.	29–30, 57

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Ragwort, common (Cont)	Amenity grass, established grassland.	Clopyralid + triclopyr (Grazon 90)	Foliar spray or weed-wiper (established grass only, off-label).	Apply to actively growing weeds.	29–30, 57
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wiper.	At or near flowering, but before onset of senescence.	36–41, 83
	Established grassland, amenity grass, road verges.	MCPA (eg <i>Headland Spear</i> , <i>MSS MCPA 50</i> )	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	41–43, 91
	Non-crop grass, non-crop areas.	Picloram ( <i>Tordon 22K</i> )	Foliar spray.	Any time of year.	45, 101
	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon 2</i> )	Foliar spray.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
	Forestry.	( <i>Garlon 4</i> or <i>Timbrel</i> )	Foliar spray.	As above.	
Ragwort, marsh <i>Senecio aquaticus</i>	Water or waterside.	2,4-D ( <i>Dormone</i> )	Foliar spray. Always consult EA, LRPA or SEPA before use.	As above.	30–32, 61
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr ( <i>Broadsword</i> or <i>Nufarm Nu-Shot</i> )	Foliar spray, weed-wipe (1/3 dilution) or rope-wick applicator (1/8 dilution).		
	Established grassland, amenity grass, road verges.	MCPA (eg <i>Headland Spear</i> , <i>MSS MCPA 50</i> )	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	41–43, 91



**Table 3: Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Rhododendron <i>Rhododendron ponticum</i>	Forestry, trees & shrubs.	Ammonium sulphamate ( <i>Amcide</i> or <i>Root-Out</i> )	Sprays to low scrub or herbaceous spp. Crystals in notches of standing shrubs.	Apr-Sept in dry weather. Any time of year.	29, 51
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr ( <i>Broadsword</i> or <i>Nufarm Nu-Shot</i> )	Conc. solution or crystals to cut stumps. Foliar spray, weed-wipe (1/3 dilution) or rope-wick applicator (1/8 dilution).	Any time of year (within 48 hours of cutting).	30-32, 61
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fencelines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Stump treatment. Apply to stumps or as foliar spray (spot-treatment) on re-growth after cutting.	Apply after felling, before re-growth. Apply foliar spray to any re-growth.	36-41, 83
	Non-crop areas, farm buildings /yards, fence-lines, forestry (site prep.), railway tracks.	Imazapyr ( <i>Arsenal</i> , <i>Arsenal 50</i> )*	Foliar spray.	Any time of year, when weeds actively growing.	41, 87
	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon 2</i> )	Foliar spray (in water), spot-treatment.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
	Forestry.	( <i>Garlon 4</i> or <i>Timbre!</i> )	Shoot, basal bark or cut stump sprays (in paraffin or diesel oil). Inject into cuts every 7.5 cm around trunk (undiluted or 1:1). [For plants >1.8 m tall: stump treatment recommended & follow-up shoot treatment may be necessary].	Winter. Not during very cold conditions.	

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Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Roses <i>Rosa</i> spp.	See woody weeds				
Rushes <i>Juncus</i> spp.	Grassland.  Conifer plantations & forestry.  Water or waterside.  Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges, aquatic situations.	2,4-D (MSS 2,4-D Amine)  (Dicotox Extra, Easel)  (Dormone)  Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Foliar spray.  As above.  As above.  Foliar spray or weed-wipe. Always consult EA, LRPA or SEPA before use in or near water.	Seedlings/young plants, when growing actively.  As above.  As above.	30–32, 61       36–41, 83
Sedges	Forestry.	Propyzamide (eg <i>Headland Judo</i> , <i>Kerb Pro Flo</i> , <i>Menace 80 EDF</i> )	Spray (active via root uptake).	Best results if applied in winter. Rain required after application, if soil is dry. Maximum of one application per year.	45–46, 103
Sow-thistles <i>Sonchus</i> spp.	Grassland.  Conifer plantations & forestry.  Water or waterside.  Established grassland, amenity grass, road verges.	2,4-D (MSS 2,4-D Amine)  (Dicotox Extra, Easel)  (Dormone)  MCPA (eg <i>Headland Spear</i> , MSS MCPA 50)	Foliar spray.  As above.  As above.  Foliar spray.	Seedlings/young plants, when growing actively.  As above.  As above.  Spring/summer (weeds actively growing, before flowering). Best results against seedlings/young plants. Not during cold weather or drought.	30–32, 61       41–43, 91

**Table 3: Cont...** (\*\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Spruce, Sitka <i>Picea sitchensis</i>	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Seedlings/young saplings controlled using weed-wiper or with hand-held sprayer (spot-treatment).  Kill larger trees with stump spray or stem injection.  Some products suitable for CDA sprayers.	Late spring/summer, trees actively growing.	36–41, 83
Swamp stonecrop, Australian <i>Crassula helmsii</i>	Non-crop areas, forestry (site prep.), railway tracks.	Imazapyr ( <i>Arsenal</i> , <i>Arsenal 50</i> )*	Foliar spray.	Any time of year, when weeds actively growing.	41, 87
	Non-crop grass, non-crop areas.	Picloram ( <i>Tordon 22K</i> )	Foliar spray.	Any time of year, but best results in late winter/early spring.	45, 101
	See Pigmyweed – New Zealand.				
Sycamore <i>Acer pseudoplatanus</i>	See woody weeds.				
Thistles <i>Cirsium</i> and <i>Carduus</i> spp.	Established grassland, broad-leaved trees.	Clopyralid ( <i>Dow Shield</i> )	Foliar sprays, weed-wiper (established grassland only, off-label).	Apply to young, actively growing seedlings. Treat creeping thistle at rosette stage. Repeat 3-4 weeks later. Do not apply when vegetation is damp or rain expected within 6 hours. Weedwipe – green bud stage after stem extension.	29–30, 57
	Amenity grass, established grass.	Clopyralid + triclopyr ( <i>Grazon 90</i> )	Foliar sprays, weed-wiper (established grass only, off-label).	Apply to actively growing weeds, before flowering stems 15 cm high. Weedwipe – green bud stage after stem extension.	

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Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Thistles (Cont)	Established grassland.	Clopyralid + triclopyr ( <i>Thistflex</i> )	Medium foliar sprays ( <b>do not apply</b> by hand-held equipment).	Apply to actively growing weeds and grass. Treat in rosette stage at size up to 200 mm high or across before stem extension.	29–30, 57
	Grassland.	2,4-D (MSS 2,4-D Amine)	Foliar spray.	Seedlings/young plants, when growing actively.	30–32, 61
	Conifer plantations & forestry.	(Dicotox Extra, EaseI)	As above.	As above.	
	Water or waterside.	(Dormone)	As above.	As above.	
	Amenity grass, non-crop grass, grass verges.	2,4-D + picloram ( <i>Atladox HI</i> )	Overall foliar spray. Not around non-target species, where spray may drift onto foliage or roots may absorb chemical.	During active growth, when foliage well developed.	30–32, 61
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fencelines, road verges.	Glyphosate (eg <i>Rival</i> or <i>Roundup Pro Biactive</i> )	Foliar sprays (spot-treatment with hand-held sprayer) or weed-wiper.	At or near flowering, but before onset of senescence.	36–41, 83
	Established grassland, amenity grass, road verges.	MCPA (eg <i>Headland Spear</i> , MSS MCPA 50)	Foliar spray.	Spring/summer (weeds actively growing, before flowering). Not during cold weather or drought.	41–43, 91
	Non-crop grass, non-crop areas.	Picloram ( <i>Tordon 22K</i> )	Foliar spray.	Any time of year.	45, 101
	Established grassland, non-crop areas.	Triclopyr ( <i>Garlon 2</i> )	Foliar spray.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
	Forestry.	( <i>Garlon 4</i> or <i>Timbrel</i> )	Foliar spray.	As above.	

**Table 3: Cont...**

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Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Traveller's-joy (Old man's beard) <i>Clematis vitalba</i>	Non-crop areas, farm buildings /yards, fence-lines, forestry (site prep.), railway tracks.  Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Imazapyr (Arsenal, Arsenal 50)*  Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar spray.  Seedlings/young saplings controlled using weed-wiper or with hand-held sprayer (spot-treatment).  Some products suitable for CDA sprayers.	Any time of year, when weeds actively growing.  Late spring/summer (leaves fully expanded, not senescent), shrubs actively growing.	41, 87  36–41, 83
	Established grassland, non-crop areas.  Forestry.	Triclopyr (Garlon 2)  (Garlon 4 or Timbrel)	Foliar spray (in water), spot-treatment.  Shoot, basal bark or cut stump sprays (in paraffin or diesel oil).	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.  Winter. Not during very cold conditions.	46, 107
Tor-grass <i>Brachypodium pinnatum</i>	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg Rival or Roundup Pro Biactive)	Foliar spray or weed-wiper.	Spring/summer, when grass actively growing. Grass with at least 4-5 new leaves & at least 10 cm tall.	36–41, 83
Water-dropwort, hemlock <i>Oenanthe crocata</i>	Aquatic situations	Dichlobenil (eg Casoron G, Sierraron G)	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.	Early spring.	33–34, 65
Water fern <i>Azolla filiculoides</i>	Aquatic situations.  Areas of water.	Glyphosate (eg Rival or Roundup Pro Biactive)  Terbutryn (Clarasan)*	Maximum permitted concentration in treated water 0.2 ppm. Always consult EA or LRPA before use.  Granules applied to water surface in static or sluggish water-bodies only.	  Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	36–41, 83  46, 105



**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Waterweed, Canadian <i>Elodea canadensis</i>	Aquatic situations.	Dichlobenil (eg Casoron G, Sierraron G)	Apply granules to surface of still or sluggish water. Always consult EA, LRPA or SEPA before use.	Early spring.	33–34, 65
	Areas of water	Terbutryn (Clarasan)*	Granules applied to water surface in static or sluggish water-bodies only. Always consult EA, LRPA or SEPA before use.	Apr-May (sometimes to Aug). During active growth, but before heavy infestation.	46, 105
Willows <i>Salix</i> spp.	Forestry.	Ammonium sulphamate (Amcide or Root-Out)	Sprays to low scrub or herbaceous spp.	Apr-Sept in dry weather.	29, 51
			Crystals in notches of standing trees.	Any time of year.	
			Conc. solution or crystals to cut stumps.	Any time of year (within 48 hours of cutting).	
	Grassland.	2,4-D (MSS 2,4-D Amine)	Foliar spray.	Seedlings/young plants, when growing actively.	30–32, 61
	Conifer plantations & forestry.	(Dicotox Extra, Easel)	As above.	As above.	
	Water or waterside.	(Dormone)	As above.	As above.	41, 87
	Non-crop areas, farm buildings /yards, fence-lines, forestry (site prep.), railway tracks.	Imazapyr (Arsenal, Arsenal 50)*	Foliar spray.	Any time of year, when weeds actively growing.	
	Established grassland, non-crop areas.	Triclopyr (Garlon 2)	Foliar spray (in water), spot-treatment.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
Forestry		(Garlon 4 or Timbrel)	Shoot, basal bark or cut stump sprays (in paraffin or diesel oil).  Inject into cuts every 7.5 cm around trunk (undiluted or 1:1).	Winter. Not during very cold conditions.	

**Table 3: Cont...** (\*\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Woody weeds	Forestry, trees & shrubs.	Ammonium sulphamate ( <i>Amcide</i> or <i>Root-Out</i> )	Sprays to low scrub or herbaceous spp. Stainless steel or plastic sprayers recommended (solutions are corrosive to mild steel, galvanised iron, brass and copper).	Apr-Sept, in dry weather (when rain is unlikely).	29, 51
			Crystals in frills or notches of trunks of standing trees.	Any time of year.	
			Concentrated solution or crystals to cut stumps.	Any time of year (within 48 hours of cutting).	29–30, 57
	Amenity grass, established grassland.	Clopyralid + triclopyr ( <i>Grazon 90</i> )	Foliar spray or weed-wiper (established grass only, off-label).	Apply to actively growing weeds. Spray broom and gorse in June-Aug period.	
	Amenity grass, established grassland.	2,4-D (eg <i>Depitox</i> )	Foliar spray. Do not mow amenity grass within two days before or one day after spraying. Do not mow or graze other grassland for at least 10 days after spraying.	Best results if applied to seedlings /young plants, when growing actively. Not during rain or when rain is imminent.	30–32, 61
	Grassland.	( <i>MSS 2,4-D Amine</i> )	As above.	As above.	
	Apple & pear orchards.	( <i>Barclay Haybob II</i> , <i>Depitox</i> , <i>Luxan 2,4-D</i> )	As above.	As above.	30–32, 61
	Conifer plantations & forestry.	( <i>Dicotox Extra</i> , <i>Easel</i> )	As above.	As above.	
	Water or waterside areas.	( <i>Dormone</i> or <i>Ragox</i> )	As above.	As above.	
	Established grassland, forestry, non-crop areas.	2,4-D + dicamba + triclopyr ( <i>Broadsword</i> or <i>Nufarm Nu-Shot</i> )	Foliar spray, weed-wipe (1/3 dilution) or ropewick applicator (1/8 dilution).  Stump treatment.	Apply after felling, before re-growth. Apply foliar spray to any re-growth.  As above.	

**Table 3: Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Target spp.	Relevant situation(s)	Herbicide(s)	Application method(s)	Timing(s)	Page refs.
Woody weeds (Cont)	Forestry, non-crop areas, waterside areas, conifer plantations (off-label).	Fosamine-ammonium (Krenite)*	Overall foliar spray (with wetter).	Aug-Oct (before leaves change colour).	36, 79
	Amenity grass & vegetation, forestry, conifers, non-crop areas, fence-lines, road verges.	Glyphosate (eg Rival or Roundup Pro Biactive)	Seedlings/young saplings controlled using weed-wiper or with hand-held sprayer (spot-treatment). Some products suitable for CDA sprayers.  Kill larger trees with stump spray or stem injection.	Late spring/summer (leaves expanded, not senescent), trees actively growing.	36–41, 83
	Total vegetation control in farm buildings/yards, fence-lines, forestry (site preparation), industrial sites, non-crop areas, railway tracks.	Imazapyr (Arsenal 50, Parade)*	Foliar spray (directed), carefully avoiding foliage and roots/root zones of non-target plants. Gives long-term residual control. Must not be used as site preparation treatment for broad-leaved trees. May be applied through CDA equipment.	Any time of year. Can be applied before weed emergence, but best results when applied to actively growing weeds. For conifer site preparation (Sitka spruce, Lodgepole pine & Corsican pine only), apply July-Oct – and at least five months before planting.	41, 87
	Non-crop grass, non-crop areas.	Picloram (Tordon 22K)	Foliar spray or pre-emergence application, avoiding foliage and roots/root zones of non-target plants.	Any time of year. Best results from foliar sprays in late winter/early spring. Persists in soil for up to two years. Maximum of one treatment per year.	45, 101
	Established grassland, non-crop areas.	Triclopyr (Garlon 2)	Foliar spray (in water), spot-treatment.	Summer (leaves fully expanded, not senescent). Not when very hot or during drought.	46, 107
	Forestry.	(Garlon 4 or Timbrel)	Shoot, basal bark or cut stump sprays (in paraffin or diesel oil).  Inject into cuts every 7.5 cm around trunk (undiluted or 1:1).	Winter. Not during very cold conditions.	

**Table 4. Key herbicides for use on nature conservation sites.**

(\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Ammonium sulphamate	Amcide	B, H & B	99.5% w/w	Annual weeds, perennial dicots., perennial grasses, woody weeds, rhododendrons.	Forestry.	None quoted.
	Root-Out	Dax	98.5% w/w	Perennial grasses, woody weeds, rhododendrons.	Forestry.	
Asulam	Asulox	RP Agric., Aventis	400 g l <sup>-1</sup>	Bracken.	Forestry, permanent pasture, rough grazing, non-crop areas.	At least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
	IT Asulam	I T Agro	400 g l <sup>-1</sup>	Docks.	Road verges, waste ground, amenity grass (not fine turf), permanent pasture.	
Clopyralid	Dow Shield	Dow	200 g l <sup>-1</sup>	Annual dicots., perennial dicots., corn marigold, creeping thistle, mayweeds.	Forestry, permanent pasture, rough grazing, amenity vegetation.	At least 7 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
				Creeping thistle.	Amenity grass (not fine turf), permanent pasture.	
				Perennial dicots., annual dicots.	Established grassland.	
					Established grassland (by weed-wiper - off-label)	
					Broad-leaved trees (off-label).	

**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Clopyralid + fluroxypyr + triclopyr	Pastor	Dow	50:75:100 g l <sup>-1</sup>	Docks, common nettle, thistles.	Established grassland.	At least 7 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
	Lonpar	Dow	35:150:175 g l <sup>-1</sup>	Creeping thistle.	Established grassland.	None quoted.
Clopyralid + triclopyr	Grazon 90	Dow	60:240 g l <sup>-1</sup>	Perennial dicots., brambles, broom, docks, gorse, common nettle, thistles. Perennial dicots.	Amenity grass, established grassland. Established grassland (by weed-wiper – off-label).	At least 7 days and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	Thistlex	Dow	200:200 g	Creeping thistle.	Permanent grassland and rotational grass.	At least 7 days before grazing or harvest.
Cycloxydim	Laser	BASF	200 g l <sup>-1</sup>	Annual grasses, perennial grasses. Green cover.	Amenity vegetation (off-label), farm forestry, forestry. Land temporarily removed from production.	None quoted.
	Standon Cycloxydim	Standon	200 g l <sup>-1</sup>	Annual grasses, perennial grasses.	Farm forestry, forestry.	
2,4-D	Agricorn D II	FCC	500 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland.	At least 14 days and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	Barclay Haybob II	Barclay	490 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland, apple and pear orchards.	



**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
2,4-D (Cont)	Depitox	Nufarm Whyte	490 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Amenity grass, established grassland, apple and pear orchards.	(See above).
	Dicotox Extra	RP Amenity, Aventis Environ	400 g l <sup>-1</sup>	Annual dicots., perennial dicots., woody weeds, heather, willows.	Conifer plantations, forestry.	
	Dioweed 50	United Phosphorus	500 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland.	
	Dormone	RP Amenity, Aventis Environ	465 g l <sup>-1</sup>	Aquatic weeds, perennial dicots.	Water or waterside areas.	
	Easel	Nufarm Whyte	500 g l <sup>-1</sup>	Annual dicots., perennial dicots.  Woody weeds, heather, willows.	Established grassland, conifer plantations, forestry.  Conifer plantations, forestry.	
	Headland Staff	Headland	470 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland.	
	Herboxone	Headland	500 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland.	
	HY-D	Agrichem	470 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Established grassland.	
	Luxan 2,4-D	Luxan	490 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland, apple and pear orchards.	At least 14 days and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	MSS 2,4-D Amine	Nufarm Whyte	500 g l <sup>-1</sup>	Annual & perennial dicots.  Aquatic weeds.	Amenity grass, grassland.  Aquatic situations.	
	Ragox	Nufarm Whyte	490 g l <sup>-1</sup>	Annual & perennial dicots.  Aquatic weeds, perennial dicots.	Amenity grass.  Water or waterside areas.	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
2,4-D (Cont)	Syford	Vitax	500 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland.	(See above).
2,4-D + dicamba + triclopyr	Broadsword Nufarm Nu-shot	United Phosphorus Nufarm Whyte	200:85:65 g l <sup>-1</sup>	Annual & perennial dicots., brambles, docks, gorse, Japanese knotweed, rhododendrons, common nettle, thistles, woody weeds.	Established grassland, forestry, non-crop grass.	At least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
2,4-D + MCPA	Headland Polo	Headland	360:315 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland.	At least 2 weeks and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
2,4-D + mecoprop-P	Sydex	Vitax	125:125 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland.	At least 2 weeks and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
2,4-D + picloram	Atladox HI	Nomix-Chipman	240:65 g l <sup>-1</sup>	Annual dicots., brambles, creeping thistle, docks, Japanese knotweed, perennial dicots., ragwort, scrub, woody weeds.	Amenity grass, non-crop grass, road verges.	At least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Do not use cuttings from treated grass for mulching or composting.
Dicamba	Cadence	Barclay	70% w/w	Chickweed, docks.	Established leys, permanent pasture.	21 days and until foliage of poisonous weeds such as ragwort and buttercups has died and become unpalatable.

**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Dicamba + MCPA + mecoprop-P	Banlene Super	Aventis	18:252:42 g l <sup>-1</sup>	Annual dicots., perennial dicots, chickweed, docks, mayweeds.	Leys, permanent pasture, established grassland.	14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
				Polygonums.	Leys.	
	Headland Relay P	Headland	25:200:200 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Leys, permanent pasture, amenity grass.	
	Hycamba Plus	Agrichem	20.4:125.9:240.2 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Amenity grass.	
	Hysward-P	Agrichem	16:101:92 g l <sup>-1</sup>	Annual dicots., perennial dicots., docks.	Established grassland, amenity grass.	
	Mircam Plus	Nufarm Whyte	19.5:245:43.3 g l <sup>-1</sup>	Annual dicots., perennial dicots., chickweed, cleavers, mayweeds, polygonums.	Grassland.	
Dicamba + maleic hydrazide + MCPA	Pastural Plus	FCC	25:200:200 g l <sup>-1</sup>	Annual dicots., perennial dicots.	Leys, permanent pasture, amenity grass.	Until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	UPL Grassland Herbicide	United Phosphorus	25:200:200 g l <sup>-1</sup>	Annual dicots., perennial dicots., chickweed, cleavers, docks, mayweeds, polygonums.	Leys, permanent pasture.	
	Mazide Selective	Vitax	6:200:75 g l <sup>-1</sup>	Annual dicots, perennial dicots, growth retardation.	Amenity grass, road verges.	
Dichlobenil	Casoron G	Syngenta, Rigby Taylor, Uniroyal, Nomix-Chipman	6.75% w/w	Aquatic weeds, total vegetation control.	Aquatic situations, non-crop areas.	None quoted.

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Dichlobenil (Cont)	Luxan Dichlobenil Granules	Luxan	6.75% w/w	Aquatic weeds, total vegetation control.	Aquatic situations, non-crop areas.	(see above).
	Sierraron G	Scotts	6.75% w/w	Aquatic weeds, total vegetation control.	Aquatic situations, non-crop areas.	
	Standon Dichlobenil 6G	Standon	6.75% w/w	Total vegetation control.	Non-crop areas.	
Dichlorprop *	MSS 2,4-DP	Nufarm-Whyte	500 g l <sup>-1</sup>	Annual dicots., perennial dicots., black bindweed, redshank.		Until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
Diquat + paraquat	PDQ	Syngenta	80:120 g l <sup>-1</sup>	Annual dicots., annual grasses, perennial non-rhizomatous grasses, volunteer cereals.	Forestry, stubbles, cultivated land/soil.	Keep livestock out of treated areas for at least 24 hours.
				Annual dicots., annual grasses.	Non-crop areas.	
				Green cover.	Field margins, land temporarily removed from production.	
				Sward destruction.	Grassland.	
Ethofumesate	Speedway 2	Scotts	2.5:2.5% w/w	Annual dicots., annual grasses, perennial grasses.	Non-crop areas.	Do not graze or cut grass for 14 days after spraying (or roll less than 7 days before or after spraying).
	Barclay Keeper 500 FL	Barclay	500 g l <sup>-1</sup>	Annual grasses, blackgrass, chickweed, cleavers, volunteer cereals.	Established grassland, leys.	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Ethofumesate (Cont)	Salute	United Phosphorus	200 g l <sup>-1</sup>	Blackgrass, chickweed, cleavers, volunteer cereals.	Established grassland, leys.	(See above).
	Standon Ethofumesate	Standon	200 g l <sup>-1</sup>	Blackgrass, chickweed, cleavers, volunteer cereals.	Established grassland, leys.	
Fluazifop- P-butyl	Fusilade 250 EW	Syngenta	250 g l <sup>-1</sup>	Annual grasses, volunteer cereals, wild oats.  Perennial grasses.  Barren brome.  Green cover.	Farm forestry, field margins.  Farm forestry.  Field margins.  Set-aside, areas temporarily removed from cropping.	Treated vegetation in field margins, set-aside, etc must not be grazed or harvested for human or animal consumption and unprotected persons must be kept out of treated areas for at least 24 hours.
	Barclay Hurler, Greencrop Reaper, Standon Fluroxypyr, Tomahawk	Barclay Greencrop  Standon  Makhteshim	200 g l <sup>-1</sup>	Annual dicots., black bindweed, chickweed, docks, forget-me-not, hemp-nettle, volunteer potatoes.	Established grassland, seedling leys.	At least 3 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable.
	Starane 2	Dow	200 g l <sup>-1</sup>	Annual dicots., black bindweed, chickweed, docks, forget-me-not, hemp-nettle, volunteer potatoes.  Cleavers, docks, stinging nettle.	Established grassland, seedling leys.  Apple & pear orchards (off-label).	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Fosamine ammonium*	Krenite	DuPont	480 g l <sup>-1</sup>	Woody weeds.	Forestry, non-crop areas, waterside areas.	None quoted.
Glufosinate ammonium	Challenge, Harvest	Aventis	150 g l <sup>-1</sup>	Annual dicots., annual grasses.	Cultivated land/soil, non-crop farm areas, stubbles.	Until poisonous weeds such as ragwort have died and become unpalatable.
				Green cover.	Land temporarily removed from production.	
				Perennial dicots.	Land temporarily removed from production, non-crop farm areas.	
				Sward destruction.	Grassland.	
Glyphosate	Challenge 60	Fargro	60 g l <sup>-1</sup>	Annual dicots., annual grasses, perennial dicots., perennial grasses.	Cultivated land/soil, shrubs.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.



**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Glyphosate (Cont)	Apache	Syngenta	220 g l <sup>-1</sup>	Annual & perennial weeds.  Bracken, rushes, sward destruction.	Land temporarily removed from production, non-crop farm areas, stubbles.  Grassland.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.
	Barclay Barbarian	Barclay	360 g l <sup>-1</sup>	Annual & perennial weeds, bracken, couch, rushes, woody weeds. Chemical thinning.  Perennial grasses, reeds, rushes, sedges, waterlilies.	Forestry.  Aquatic situations.	
	Barclay Gallup Amenity,  Barclay Gallup Biograde Amenity.	Barclay	360 g l <sup>-1</sup>	Annual & perennial weeds, bracken, couch, heather, rhododendrons, woody weeds. Chemical thinning.  Annual & perennial weeds.	Forestry.  Amenity areas, amenity areas (wiper application), road verges.  Amenity trees & shrubs, broadleaved trees. <b>(Barclay Gallup Amenity only)</b> ,  Aquatic situations.	
				Perennial grasses, reeds, rushes, sedges, waterlilies.		

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Glyphosate (Cont)	Buggy SG	Sipcam	36% w/w (water dispersible granules)	Annual & perennial weeds.	Forestry, grassland, cherries, damsons, plums, land not intended to bear vegetation.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.
				Bracken, heather, rhododendrons, woody weeds.	Forestry.	
				Couch.	Grassland, stubbles.	
				Perennial grasses.	Tolerant conifers.	
				Perennial grasses, reeds, rushes, sedges, water-lilies.	Aquatic situations.	
	Glyfos ProActive	Nomix-Chipman	360 g l <sup>-1</sup>	Annual & perennial weeds.	Forestry, industrial sites, land not intended to bear vegetation.	
				Bracken, heather, rhododendrons, woody weeds.	Forestry.	
				Perennial grasses.	Tolerant conifers.	
				Total vegetation control.	Amenity vegetation, land not intended to bear vegetation, fencelines, road verges, hard surfaces.	
	Hilite	Nomix-Chipman	144 g l <sup>-1</sup> (ready-to-use spray)	Perennial grasses, reeds, rushes, sedges, water-lilies.	Aquatic situations.	
				Annual & perennial weeds, woody weeds.	Forestry.	

**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Glyphosate (Cont)	Hilife (Cont)			Annual & perennial weeds. Total vegetation control. Sward destruction.	Hedges, amenity trees & shrubs. Amenity areas, hard surfaces, industrial sites. Amenity grass.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.
	Rival, Roundup Pro Biactive	Monsanto	360 g l <sup>-1</sup>	Annual and perennial weeds.  Bracken.  Brambles, perennial grasses, woody weeds. Perennial dicots. Couch, rushes, rhododendrons, woody weeds. Chemical thinning.	Amenity areas (including wiper application), amenity grass (including wiper application), amenity trees & shrubs (including wiper application), amenity vegetation, broad-leaved trees, conifers, fencelines, forestry, hard surfaces, industrial sites, land clearance, land not intended to bear vegetation, non-crop areas, road verges, walls.  Amenity trees & shrubs, fencelines, land clearance, non-crop areas, forestry, tolerant conifers.  Tolerant conifers.  Forestry (including wiper application).  Forestry.	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Glyphosate (Cont)	Rival, Roundup Pro Biactive (Cont)	Monsanto	360 g l <sup>-1</sup>	Sward destruction.  Total vegetation control.  Perennial grasses, reeds, rushes, sedges, water-lilies.	Amenity grass.  Amenity areas, amenity vegetation, land not intended to bear vegetation., fencelines, road verges, hard surfaces, industrial sites.  Aquatic situations.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.
	Roundup	Monsanto	360 g l <sup>-1</sup>	Annual and perennial weeds.	Grassland, apple & pear orchards, cherries, damsons, plums, non-crop farm areas, stubbles.	
	Spasor	RP Amenity Aventis Environ.	360 g l <sup>-1</sup>	Annual & perennial weeds.  Total vegetation control.  Perennial grasses, reeds, rushes, sedges, water-lilies.	Amenity grass (including wiper application), amenity trees & shrubs (including wiper application).  Amenity areas, fencelines, road verges.  Aquatic situations.	
	Stirrup	Nomix-Chipman	144 g l <sup>-1</sup> (ready-to-use spray)	Annual & perennial weeds.  Woody weeds.  Sward destruction.  Total vegetation control.	Amenity trees & shrubs, forestry, hedges, top fruit (all).  Forestry.  Amenity grass.  Amenity areas, hard surfaces, industrial sites.	

**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Glyphosate (Cont)	Touchdown LA	Syngenta	330 g l <sup>-1</sup> (trimesium salt)	Annual & perennial weeds, bracken.	Amenity trees & shrubs, fencelines, land clearance, non-crop areas.	Exclude livestock from treated fields. Livestock may not graze or be fed the treated forage, nor may it be used for hay, silage or bedding.
	Imazapyr*	Nomix-Chipman	50 g l <sup>-1</sup>	Bracken, total vegetation control.	Forestry, fence-lines ( <b>site preparation</b> ), industrial sites, non-crop areas, railway tracks.	None quoted.
Maleic hydrazide	Mazide 25	Vita x	250 g l <sup>-1</sup>	Growth retardation/ suppression. Sucker inhibition.	Amenity grass, hedges, road verges. Amenity trees & shrubs.	Only applied to grass, not to be used for grazing.
	Regulox K	Aventis Environ.	250 g l <sup>-1</sup>	Growth suppression.	Amenity grass, grass near water, industrial sites, roadside grass, waste ground.	
				Sucker inhibition.	Amenity trees & shrubs.	
	Royal MH 180	Nufarm Whyte	180 g l <sup>-1</sup>	Growth suppression.	Amenity grass, road verges, grass near water.	
MCPA	Agricorn 500 II	FCC	500 g l <sup>-1</sup>	Annual & perennial dicots., buttercups, dandelions, docks.	Established grassland.	Until foliage of poisonous weeds such as ragwort has died and become unpalatable.
	Agritox 50, Barclay Meadowman II	Nufarm Whyte Barclay	500 g l <sup>-1</sup>	Annual & perennial dicots., charlock, fat-hen, hemp nettle, wild radish.	Established grassland.	
	Agroxone	Headland	485 g l <sup>-1</sup>	Annual & perennial dicots., charlock, fat-hen, hemp nettle, wild radish.	Established grassland, newly sown grass.	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
MCPA (Cont)	BASF MCPA Amine 50	BASF	500 g l <sup>-1</sup>	Annual & perennial dicots., buttercups, dandelions, docks, thistles.	Established grassland.	Until foliage of poisonous weeds such as ragwort has died and become unpalatable.
	Campbell's MCPA 50	MTM Agrochem	500 g l <sup>-1</sup>	Annual & perennial dicots., buttercups, dandelions, docks, thistles.	Established grassland.	
	Headland Spear	Headland	500 g l <sup>-1</sup>	Annual & perennial dicots., buttercups.  Docks, ragwort, rushes, thistles.  Stinging nettle, thistles.	Amenity grass, established grassland.  Established grassland.  Industrial sites, land not intended to bear vegetation.	
	HY-MCPA	Agrichem	500 g l <sup>-1</sup>	Annual dicots., perennial dicots., dandelions, docks, thistles.  Annual dicots., perennial dicots., charlock, fat-hen, hemp nettle, wild radish.	Established grassland.  Young leys.	
	Luxan MCPA 500, MCPA 25%	Luxan Nufarm Whyte	500 g l <sup>-1</sup> 235 g l <sup>-1</sup>	Annual dicots., perennial dicots., charlock, fat-hen, hemp nettle, wild radish.	Established grassland, newly sown grass.	
	MSS MCPA 50	Nufarm Whyte	500 g l <sup>-1</sup>	Annual & perennial dicots., buttercups, dandelions, docks, thistles.  Annual dicots., creeping thistles, daisies, docks.	Established grassland.  Road verges.	



**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
MCPA + MCPB	Butoxone Plus	Headland	25:275 g l <sup>-1</sup>	Annual & perennial dicots.	Permanent pasture.	Until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	MSS MCPB + MCPA	Nufarm Whyte	25:275 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland, leys.	
	Triflex-Tra	BASF	34:216 g l <sup>-1</sup>	Annual & perennial dicots.	Established grassland, leys.	
	Tropotox Plus	Nufarm Whyte	37.5:262.5 g l <sup>-1</sup>	Annual & perennial dicots.	Established leys, permanent pasture.	
MCPA + mecoprop-P	Greenmaster Extra	Scotts	0.49:0.29% w/w (granules, also containing NPK fertiliser)	Annual & perennial dicots.	Amenity grass.	At least 2 weeks and until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
MCPB	Butoxone	Headland	400 g l <sup>-1</sup>	Annual & perennial dicots.	Permanent pasture.	Until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
Mecoprop-P	Clenecorn Super, Compitox Plus, Duplosan KV, Isomec	FCC Nufarm Whyte BASF Nufarm Whyte	600 g l <sup>-1</sup>	Annual & perennial dicots., chickweed, cleavers.	Grassland, young leys.	At least 2 weeks and until foliage of any poisonous weeds, such as ragwort, has died and become unpalatable.
	Landgold Mecoprop-P 600	Landgold	600 g l <sup>-1</sup>	Annual & perennial dicots., chickweed, cleavers.	Established grassland, leys.	
	Optica	Headland	600 g l <sup>-1</sup>	Annual & perennial dicots., chickweed, cleavers.	Established grassland, young leys.	
Mefluidide	Embark Lite	Intracrop	24 g l <sup>-1</sup>	Suppression of grass (plant growth regulator).	Amenity grass, managed amenity turf.	Treated grass not to be used for animal consumption.

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Paraquat	Barclay Total	Barclay	200 g l <sup>-1</sup>	Annual dicots., annual grasses, creeping bent.	Forestry, non-crop areas, stubbles.	At least 24 hours.
				Firebreak desiccation.	Forestry.	
				Perennial ryegrass, rough meadow-grass.	Non-crop areas.	
				Annual grasses, annual dicots., creeping bent, perennial ryegrass, rough meadow-grass.	Grassland (sward destruction/direct drilling), orchards.	
				Barren brome, volunteer cereals, wild oats.	Stubbles.	
				Green cover.	Land temporarily removed from production.	
	Dextrone X	Nomix-Chipman	200 g l <sup>-1</sup>	Annual dicots., annual grasses, creeping bent.	Forestry, non-crop areas.	
				Firebreak desiccation.	Forestry.	
				Perennial ryegrass, rough meadow-grass.	Non-crop areas.	
	Gramoxone 100	Syngenta	200 g l <sup>-1</sup>	Annual dicots., annual grasses, creeping bent.	All top fruit, forestry, non-crop areas, stubbles.	
				Firebreak desiccation.	Forestry.	
				Perennial ryegrass, rough meadow-grass.	All top fruit, non-crop areas.	

**Table 4. Cont...** (\*Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Paraquat (Cont)	Gramoxone 100 (Cont)			Annual grasses, creeping bent, perennial ryegrass, rough meadow-grass.  Volunteer cereals, barren brome, wild oats.  Green cover.	Grassland (sward destruction/ direct drilling).  Stubbles.  Field margins, land temporarily removed from production.	(See above).
	Tordon 22K	Nomix-Chipman	240 g l <sup>-1</sup>	Annual & perennial dicots., bracken, Japanese knotweed, woody weeds.	Non-crop areas, non-crop grass.	Until foliage of any poisonous weeds such as ragwort has died and become unpalatable.
	Greencrop Saffron FL	Greencrop	400 g l <sup>-1</sup>	Annual dicots., annual & perennial grasses.	Apple & pear orchards, plums.	None quoted.
Propyzamide	Kerb 50 W	Dow	50% w/w	Annual dicots., annual & perennial grasses.	Farm woodland.	
	Kerb 80 EDF, Menace 80 EDF	Dow	80% w/w	Annual dicots., annual & perennial grasses.  Horsetails, sedges, perennial grasses.	Apple & pear orchards, plums.  Forestry.	
	Kerb Granules, Kerb Pro Granules	SumiAgro SumiAgro Amenity	4% w/w (granules)	Annual dicots., annual & perennial grasses.	Forestry, trees & shrubs.	
	Kerb Pro Flo	SumiAgro Amenity	400 g l <sup>-1</sup>	Annual dicots., annual & perennial grasses.  Horsetails, sedges.	Apple & pear orchards, plums.  Forestry.	

**Table 4. Cont...** (\* Approvals for sale and supply of products containing these herbicides are revoked on 25 July 2003 and they must be used up by 31 December 2003).

Herbicide	Approved products	Manufacturer/ distributor	Formulation (a.i. conc.)	Plants controlled	Relevant approved uses	Stock-withholding period
Propyzamide (Cont)	Redeem Flo	Dow	400 g l <sup>-1</sup>	Annual dicots., annual & perennial grasses. Horsetails, sedges, perennial grasses.	Areas of water.	(See above).
Terbutryn*	Clarosan	Scotts	1% w/w (granules)	Aquatic weeds.	Forestry, land not intended to bear vegetation.	None quoted.
Triclopyr	Chipman Garlon 4, Garlon 4 Timbrel Triptic 48 EC	Nomix-Chipman Dow Dow United Phosphorus	480 g l <sup>-1</sup>	Perennial dicots., brambles, broom, docks, gorse, rhododendron, common nettle, woody weeds.	Established grassland, land not intended to bear vegetation, non-crop areas (directed treatment).	At least 7 days and until foliage of poisonous weeds such as buttercups or ragwort has died and become unpalatable.
	Garlon 2	Syngenta	240 g l <sup>-1</sup>	Perennial dicots., brambles, broom, docks, gorse, hard rush, common nettle, woody weeds. Scrub clearance.	Land not intended to bear vegetation, non-crop areas (directed treatment).	

## 4.1.3 Herbicide information summary sheets – layout

### 4.1.3.1 Introduction

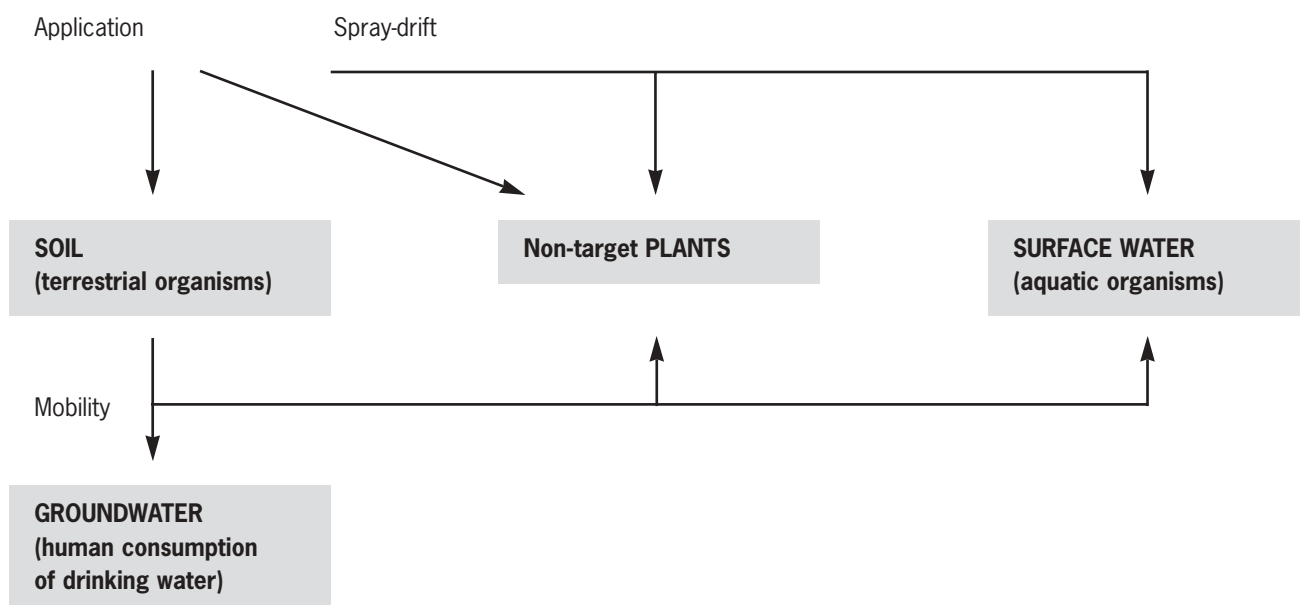
The sheets are focussed on the active ingredient rather than the formulated product (which may contain more than one active ingredient). Data are presented so as to inform and orientate the user with respect to the properties of the active ingredient. **The sheets do not replace the product label, or the approval, which remains the final authoritative legal instrument for the provision of usage instructions.** The information in the summary sheets helps the user to make an informed decision as to the likely risks to the environment of using the compound under the actual local use conditions. The data allow a qualitative, rather than quantitative, risk assessment, although all the compounds (and authorised products) have been assessed by PSD and deemed to be safe for the approved use.

In this section, an attempt has been made to inform the user about the type of data included, as well as the limitations of those data. An outline of how the data could be used to aid in the risk assessment process is also given.

### 4.1.3.2 Non-target organisms at risk

Clearly, non-target species (plants, mammals, birds, invertebrates, etc) within the actual targeted treatment area may be exposed, unless a very precise application method is employed (such as a weed-wiper). Non-target species outside of the target area (both terrestrial and aquatic, including plants) might be exposed through spray drift, or via the movement of residues in water either downward through the soil (leaching), or sideways over the soil surface (run-off). Plants might also be exposed via root uptake of a mobile compound moving through the soil water. Some compounds may exert effects after application via vapour drift. Downward movement of the compound through the soil might also contaminate groundwater. Groundwater has a special status in the EU because it more readily contributes to drinking water than surface waters do. There is a legal requirement that any specific herbicide must not exceed a concentration of 0.1 µg/litre in drinking water.

The following diagram summarises the non-target organisms that might be at risk following application of a herbicide.



#### 4.1.3.3 Sources and limitations of the data

Unfortunately, the data included cannot be regarded as exhaustive, for two reasons. Firstly, the compounds would not have been tested under many of the exact local environmental conditions faced in the field. Secondly, data generated by approval holders were not generally available. Only publicly available sources have been used to obtain data (and all sources are referenced). This means that the data should not be regarded as definitive for any given local circumstance, but may be used as indicative of the issues likely to be most pertinent for consideration. The main sources used for each section are summarised below.

#### Data sections included

- **Heading and summary**

The name and chemical structure of the active ingredient is given, together with an example product name and formulation type. Many other equivalent products are often also available and inclusion of a specific example should not be regarded as an endorsement. The summary seeks to encapsulate the key points, from an environmental point of view, but also includes information on the compound type and mode of transport into the plant.

- **Application scenarios**

Approved uses (as given by PSD) are summarised, including only those categories pertinent to use on conservation sites. Most of the active ingredients are also registered for use on agricultural crops. General application timings, application methods and special warnings/instructions are also included (this information is derived from product labels/technical leaflets).

- **Fate in soil; Fate in water**

Where available, quantitative data are given for the various parameters that have a bearing on the fate of the herbicide in soil and water. The compound's water solubility is given together with data relating to how fast it degrades (time required for 50% to dissipate or 'DT<sub>50</sub>'). The strength of the binding of the compound to soil is also indicated, either through the K<sub>d</sub> value (a measure of the partitioning of the compound between soil and water) or more normally via the K<sub>oc</sub> value (the partitioning between soil and water normalised to the soil organic carbon content). The logK<sub>ow</sub> value is also given, which is an indication of how tightly the compound will associate with fat, and this is a measure of its propensity to bioaccumulate. Data included in this section have been derived from various sources (eg *The pesticide manual*, PSD evaluation documents, US-EPA review documents, product labels and various Internet sources).

- **Effects on terrestrial fauna; effects on aquatic fauna**

These two sections give information on the nature of the hazard for non-plant organisms of being exposed to the compound, either in the soil or in water. The data take the form of toxicity parameters, measured for various organisms. The LD<sub>50</sub> value is the dose of the herbicide found to be lethal to 50% of individuals; the LC<sub>50</sub> value is the concentration of the herbicide found to be lethal to 50% of individuals. The EC<sub>50</sub> value is the concentration of the herbicide found to have an adverse effect on 50% of individuals. The organisms tested are regarded as indicator species for the organism type. Although broadly similar susceptibilities may be assumed for related organisms, susceptibility of even closely related species can sometimes vary by several orders of magnitude, so a degree of uncertainty should be assumed. Data included in this section has been derived from various sources (eg *The pesticide manual*, PSD evaluation documents, US-EPA review documents, product labels and various Internet sources).

- **Effects on non-target plants; efficacy/safety**

These two sections cover the herbicidal activity of the compound. The product label and general environmental profile of the herbicide has been used to generate general advice regarding the threat to non-target plants posed by exposure to the herbicide. Specific data on weed susceptibility are presented in the form of tables.

Weed susceptibility data have been derived from product labels, research papers and a few Internet sources. It must be emphasised that these data have usually been generated in cropping situations very different to those encountered on nature conservation sites and it should not be assumed that a non-target species would be safe from danger because it is listed as 'resistant' in the tables. The tables should be used as an indication of likely susceptibilities, but experience and caution should inform the user's interpretation and use of the data. The absence of a species from the tables does not indicate safety. It should also be remembered that the summary sheets are active ingredient focussed and that a particular product may contain more than one active ingredient.



#### 4.1.3.4 Using the herbicide information summary sheets

##### General

First, consider whether a herbicide is needed at all – other non-herbicide options should be used where possible. Consider, too, whether the problem is likely to be dealt with by a single treatment, or may need several, or even ongoing, treatments. This should influence the strategy adopted for dealing with the problem.

Identify the weed problem. Think about the specific location in terms of non-target species (plants, invertebrates, birds, animals), nearby water, and soil type. What, in the location, especially needs protecting from undesirable affects of any herbicide treatment? What are the risks if the weed is NOT controlled? Seek advice from specialists over the control option that has been considered and its risks if there is any doubt.

Use can be made of Table 3 (Target species and possible herbicides for their control) and Table 4 (Key herbicides for use in nature conservation sites) to identify candidate actives/products that could be used to control the target weeds. The weed susceptibility tables in the summary sheets can also provide an indication of appropriate actives. However, any candidate herbicide must be approved for use in the target circumstances and any product label restrictions must be adhered to.

##### Application method

The method of application will have a significant effect on the exposure of non-target species to the herbicide. The application should be targeted as much as possible and it is worth remembering that contamination by spray drift will be the largest source of non-target exposure in most cases. Consider if the application methods available, and the weed susceptibility data, suggest that an acceptable treatment can be carried out. Some of the herbicides can move considerable distances in soil water and exert adverse effects following uptake by plant roots. The herbicide summary sheets indicate where this is a concern, based on the physical properties of the compound and its mode of transport into the plant.

##### Non-target plants

Within the target area, consider the non-target plants and review the candidate actives for activity against these (remembering that the tables are not exhaustive). Where there are especially rare or important non-target species within the target area reconsider the option of not using chemical control unless experience or specific advice clearly indicates that a candidate herbicide will not have adverse effects. Review non-target plants **close** to the target area in the same way.

##### Non-target soil organisms

Assess the presence of particularly rare/important soil organisms within the target area and very close by. There is little information available with respect to adverse effects on soil organisms for the herbicides, but consider what is available.

##### Non-target aquatic organisms

Where the target area is water (for the control of aquatic weeds), ensure that the product label instructions are **very** carefully followed. For terrestrial applications, ensure that the intended herbicide application will not result in any over-spray of neighbouring watercourses.

Water bodies can also become contaminated via spray drift – avoid this by appropriate choice of application method/equipment and appropriate consideration of local weather conditions at the proposed time of treatment.

Movement of herbicide away from the target area into surface waters can occur by run-off and also following downward leaching coupled with lateral water flow. Assess this risk by consideration of both the properties of the compound and the local soil/topography. For example, clay soils on slopes may be prone to run-off events and sandy soils with underlying impermeable soil layers may be prone to downward leaching followed by lateral movement of water. Some herbicides have very high  $K_{oc}$  (or  $K_d$ ) values which would imply less of a risk of mobility via water flow. Others may have very fast degradation rates in soil (ie short soil  $DT_{50}$  values), again indicative of less of a risk of movement away from the target area. Some herbicides degrade very fast in water and would therefore pose less of a risk of generating adverse effects if they reached watercourses.

Relatively persistent herbicides (either in the soil or in water) represent an increased risk of water contamination. When this is coupled with a higher risk of bioaccumulation (higher  $\log K_{ow}$  value), then the possibility of long-term effects should be considered (and avoided).

##### Groundwater

As indicated above, the protection of groundwater from contamination by herbicides has a special status in the EU. Generally, downward movement of herbicides is to be avoided. This leaching depends upon the soil type and the properties of the compound (soil  $DT_{50}$ ,  $K_{oc}$ ), but approval of the herbicide by PSD indicates that PSD do not consider contamination of groundwater to be a significant risk under normal circumstances. Nevertheless, where the treatment site is considered to be particularly vulnerable to downward movement of water then specific consideration is required of the risk of using the candidate herbicide, as indicated in the summary sheets.





## Ammonium sulphamate

(eg Amcide, Root-Out; inorganic salt crystals)

### Summary

Ammonium sulphamate is an inorganic, non-selective, post-emergent, contact herbicide. It is systemic and is adsorbed by the leaves, roots, stems and freshly cut wood surfaces followed by translocation. The active component is extremely water-soluble and could be expected to contaminate surface water, under some circumstances. There is also a risk that it could leach into ground water. However, it is virtually non-toxic to mammals and other wildlife and not expected to adversely impact soil and aquatic fauna. Direct contamination of watercourses should be especially avoided.

### Application scenarios

Ammonium sulphamate is registered for the control of perennial and woody weeds and trees (and tree stumps) in forestry and non-crop land<sup>1,2</sup>. Activity is best during the growing season, corresponding to summer, but it can be applied at any time between April and September. Application is either in water solution, as a foliar spray for control of woody plants; or as crystals, or concentrated solution, to cuts in the bark or on freshly-cut stumps of undesirable trees, to prevent resprouting<sup>2</sup>.

### Fate in soil

There is very little data available on the fate of ammonium sulphamate in the soil, but it is believed to disappear from soil within 6-8 weeks of application and is likely to degrade to ammonium sulphate<sup>3</sup>. The compound is extremely soluble in water (2.3 kg l<sup>-1</sup>)<sup>4</sup> and is not bound to soil. Therefore, there is a risk of leaching and movement to surface water, via run-off and drainage (especially immediately following application).

### Fate in water

No information is available regarding the fate of ammonium sulphamate in water. Its high water solubility prevents significant binding to sediments and also indicates a low bioaccumulation potential in aquatic species (fish, etc).

### Effects on terrestrial fauna

Generally, ammonium sulphamate is regarded as moderately toxic<sup>5</sup> with an oral LD<sub>50</sub> in rats of 1600 mg kg<sup>-1</sup>. It may cause some irritation to the skin or eye<sup>4</sup>. The risk to birds is considered to be low (oral LD<sub>50</sub> for quail 3000 mg kg<sup>-1</sup>)<sup>3</sup> and ammonium sulphamate is non-toxic to bees and believed not to be a risk to deer<sup>5</sup>.

### Effects on aquatic fauna

Ammonium sulphamate has been found to be of low toxicity to fish (LC<sub>50</sub> 1,000 mg l<sup>-1</sup>)<sup>3</sup> but, given the high application rates, use of ammonium sulphamate near to water should be considered as posing a potential risk to fish. No specific data are available regarding toxicity to other aquatic species (eg water fleas or algae) and, as such, ammonium sulphamate should be regarded as posing a potential risk to these species.

### Effects on non-target plants

Ammonium sulphamate is a non-selective herbicide and would, therefore, be expected to pose a threat to non-target plant species. However, bracken, bindweed, sedges and cock's-foot grass are not fully controlled and would be expected to re-grow from roots in about 8 weeks<sup>2</sup>.

### Efficacy/safety<sup>2,6</sup>

See table overleaf

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible (to foliar sprays at 500 kg per ha):

**Pteridophytes:** Horsetails.

**Daisy family (Asteraceae):** Common ragwort, creeping buttercup, dandelion, mugwort, spear thistle.

**Other dicotyledons:** Clover, hogweed, plantain, willowherb.

#### Susceptible (to foliar sprays at 1,000 kg per ha):

**Grasses:** False oat-grass.

**Daisy family (Asteraceae):** Thistles.

**Other dicotyledons:** Bramble, common nettle, docks, ground-elder, mare's-tail.

#### Susceptible (to stump treatment at 400 g l<sup>-1</sup>):

**Trees & shrubs:** Ash, beech, birch, blackthorn, dogwood, elder, hawthorn, hazel, holly, hornbeam, Japanese knotweed, laurel, oak, poplar, rhododendron, sycamore, willow.

#### Moderately susceptible (at 1,000 kg ha<sup>-1</sup>):

**Grasses:** Common couch.

**Dicotyledons:** Dead-nettle.

#### Moderately resistant (at 1,000 kg ha<sup>-1</sup>):

**Ferns:** Bracken.

**Grasses:** Cock's-foot.

**Other monocotyledons:** Sedges.

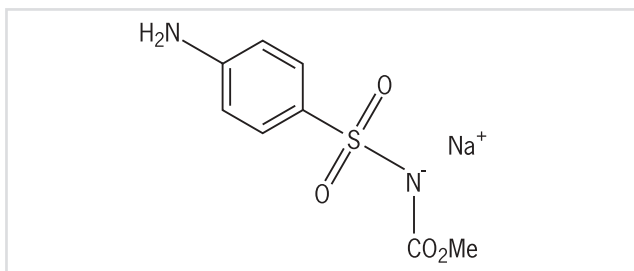
**Dicotyledons:** Bindweed.

#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Battle Hayward and Bower Ltd. *Amcide* product label.
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- (4) Dax Products Ltd, Root-Out safety data sheet.  
([www.daxproducts.co.uk/rootcoshh.html](http://www.daxproducts.co.uk/rootcoshh.html)).
- (5) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (6) Dax Products Ltd, Root-Out user's information  
([www.daxproducts.co.uk](http://www.daxproducts.co.uk)).



### Summary

Asulam is a selective, post-emergent, systemic, carbamate herbicide. It is absorbed by leaves, shoots and roots, with translocation in both the symplastic and apoplastic systems to other parts of the plant. The active component is very water-soluble and could be expected to contaminate surface water, under some circumstances. However, it is rapidly degraded in soil and water, virtually non-toxic to mammals and other wildlife, and not expected to adversely impact soil and aquatic fauna. Nevertheless, every effort should be made to avoid direct contamination of watercourses.

### Application scenarios

Asulam is registered for the control of a variety of annual grasses and broadleaved weeds (but especially bracken and docks) in amenity grassland, amenity vegetation, permanent and rotational grassland, established orchards, forestry and hops<sup>1</sup>. Use is normally within the period early July to late August (early August in northern Britain). Application can be by tractor-mounted sprayer, hand-operated knapsack and via helicopter<sup>2</sup>.

### Fate in soil

Asulam is known to degrade very fast, through microbial action, in aerobic soil systems (DT<sub>50</sub> values ranging from 6–14 days)<sup>3</sup>, but much more slowly under anaerobic conditions<sup>4</sup>. The sodium salt, asulam, is very water soluble (>600 l<sup>1</sup>)<sup>3</sup> and is not bound tightly to soil (K<sub>oc</sub> values range from 18–115)<sup>4</sup>. Therefore, there is a risk of leaching and movement to surface water via run-off and drainage (especially immediately following application). But, this risk is expected to be low and to decrease rapidly with time after application, due to the very fast degradation in soil. Asulam also degrades rapidly in soil through the action of sunlight<sup>4</sup>.

### Fate in water

Although not susceptible to hydrolysis, asulam is degraded rapidly in water through the action of sunlight<sup>4</sup>. Its high water solubility prevents significant binding to sediments and also indicates a low bioaccumulation potential in aquatic species (fish, etc).

### Effects on terrestrial fauna

Generally, asulam is regarded as essentially non-toxic<sup>4</sup>, with an oral LD<sub>50</sub> in the rat of >5,000 mg kg<sup>-1</sup> and dermal LD<sub>50</sub> in the rabbit of >4,000 mg kg<sup>-1</sup>. It does not cause skin sensitisation and is only slightly irritating to the eye<sup>4</sup>. The

## Asulam

(eg Asulox; soluble concentrate)

risk to birds is considered very low (oral LD<sub>50</sub> for ducks >4000 mg kg<sup>-1</sup>)<sup>3</sup> and asulam is non-toxic to bees (LD<sub>50</sub> 36.26 mg per bee)<sup>4</sup>.

### Effects on aquatic fauna

Asulam has been found to be non-toxic to fish (LC<sub>50</sub> >5,000 mg l<sup>-1</sup>)<sup>3</sup> and moderately toxic to water fleas (acute EC<sub>50</sub> 27 mg l<sup>-1</sup>)<sup>4</sup>. Asulam is markedly more toxic to algae (eg *Selenastrum capricornutum* EC<sub>50</sub> 0.18 mg l<sup>-1</sup>)<sup>4</sup>.

### Effects on non-target plants

Ferns and bryophytes (mosses and liverworts) are generally highly sensitive to asulam<sup>5</sup>. Laboratory bioassays and glasshouse studies have indicated that most bryophyte and fern species are slightly more susceptible to damage than common sorrel seedlings (a highly sensitive species), but may take longer to exhibit symptoms of phytotoxicity. Although all ferns appear to be damaged by asulam applied at the rate recommended for bracken control (4,400 g a.i. ha<sup>-1</sup>), not all species show a similar response. Bracken is actually one of the least sensitive of British fern species. Hard fern is particularly sensitive. Several ferns may be significantly damaged when exposed to low rates of asulam (440 g a.i. ha<sup>-1</sup>) but not by very low rates (20 g a.i. ha<sup>-1</sup>)<sup>5</sup>. However, it is possible that uncontrolled bracken may pose a greater threat to rare bryophytes and ferns than the potential of direct asulam damage<sup>5</sup>. Grasses are generally less susceptible than common sorrel.

When treating for bracken and docks it should be expected that damage to some grasses and herbs will also occur, but any adverse effects will be temporary. However, more sensitive species include Yorkshire fog, Timothy, cock's-foot, bents, annual meadow-grass, daisy, plantains and saxifrages.

An investigation of the impact of asulam herbicide drift on non-target plant species such as cuckooflower, common knapweed, selfheal, ragged-robin, betony and red campion found that the main signs of plant damage were reduction in size, leaf chlorosis, leaf necrosis, epinasty and near death. Herbicide effects were generally greater at higher wind speeds (3.5 m s<sup>-1</sup> compared to 2.5 m s<sup>-1</sup>). In autumn experiments, between 10% and 12% of plants were damaged (most being reduced in size).

With respect to trees, most species are unaffected. However, young trees of some species may exhibit chlorosis and a slight check in growth, if directly sprayed whilst

actively growing. Bilberry, gorse and heather may be similarly affected. Mature specimens of the above species - as well as hawthorn, holly and rowan - will be unharmed. Western hemlock and willows are more susceptible and spraying of these species should be avoided<sup>2</sup>.

Aquatic plants are known to be relatively sensitive (eg fat duckweed EC<sub>50</sub> 0.14 mg l<sup>-1</sup>)<sup>4</sup> to asulam and the risk to aquatic plants should be taken into account during application.

#### Efficacy/safety<sup>2,5,6,7</sup>

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Terrestrial species

##### Susceptible:

**Ferns:** Beech fern, bracken, broad buckler-fern, hard-fern, lady-fern, lemon-scented fern, mountain fern, narrow buckler-fern, scaly male-fern.

**Grasses:** Barleys, bents, blackgrass, bromes, bur/rough bristle-grass, cat's-ear, cock's-foot, cockspur, creeping soft-grass, crested dog's-tail, fescues, finger-grasses, green bristle-grass, lesser quaking grass, mat-grass, meadow-grasses, orange foxtail, Timothy, wild oat, Yorkshire fog.

**Conifers:** Western hemlock.

**Other trees and shrubs:** Downy birch, willows.

**Daisy family:** Canadian fleabane, cat's-ear, common ragwort, cotton thistle, cudweeds, daisy, dandelion, groundsel, mayweeds, mugworts & wormwoods, prickly lettuce, ragweeds, smooth sow-thistle, Spanish-needles, sunflower.

**Cabbage family (Brassicaceae):** Charlock, field pennycress.

**Pea family (Fabaceae):** Common bird's-foot-trefoil, red clover (seedlings), white clover (seedlings).

**Carrot family (Apiaceae):** Wild carrot.

**Knotweed family (Polygonaceae):** Black bindweed, docks & sorrels, knotgrass, pinkweed, redshank.

**Other dicotyledons:** Apple-of-Peru, ribwort plantain, saxifrages.

##### Moderately susceptible:

**Pteridophytes:** Field horsetail.

**Grasses:** Bermuda-grass, black bent, common bent, drooping brome, crested dog's-tail, Italian rye-grass (seedlings), meadow fescue, meadow fox-tail, perennial ryegrass (seedlings), sheep's fescue, silvery hair-grass, velvet bent, witch-grass.

**Conifers:** Young specimens of Corsican pine, Douglas fir, grand fir, Japanese larch, Norway spruce, Sitka spruce, Scots pine.

**Other trees and shrubs:** Young beech, birch, elm, gorse, poplar. Western gorse and willows.

**Daisy family (Asteraceae):** Autumn hawkbit, bristly hawk's-beard, cat's-ear, colt's-foot, creeping thistle, goldenrods, perennial sow-thistle, prickly lettuce, spear thistle.

**Cabbage family (Brassicaceae):** Shepherd's purse, hedge mustard, treacle mustard, wild radish.

**Pea family (Fabaceae):** Beans, clovers (established plants).

**Other dicotyledons:** Bramble, common nettle, heather, Japanese-lanterns, lesser spearwort, plantains, small nettle.

##### Moderately resistant:

**Pteridophytes:** Wood horsetail.

**Grasses:** Common couch, Italian ryegrass (established), perennial ryegrass (established), purple moor-grass, reed sweet-grass.

**Other monocotyledons:** Bulbous rush, sharp-flowered rush.

**Conifers:** Japanese larch.

**Other trees & shrubs:** Gorse, wild privet.

**Pea family (Fabaceae):** Greater bird's-foot-trefoil, lucerne/sickle medick, meadow vetchling.

**Other dicotyledons:** Amaranths, American cranberry, bilberry, bindweeds, bulbous buttercup, coffee senna, common chickweed, common purslane, eyebright, goosefoots, heather, least mallow, morning-glories, velvetleaf.



## Resistant:

**Mosses & lichens:** *Cladonia* spp., *Polytrichum commune*, *Rhytidiadelphus squarrosus*, bog-mosses.

**Grasses:** Common reed.

**Other monocotyledons:** Common cottongrass, common spike-rush, sedges, common cotton-grass, soft rush, compact rush, wood-rushes, floating club-rush.

**Conifers:** Lodgepole pine, giant fir.

**Other trees and shrubs:** Ash, beech, crab apple, elder, hawthorn, holly, juniper, oaks, rowan, sycamore, yew.

**Daisy family (Asteraceae):** Autumn hawkbit, bristly ox-tongue, cocklebur, fleabanes, sneezewort, yarrow.

**Cabbage family (Brassicaceae):** African pepperwort, cuckoo-flower, hoary cress.

**Pea family (Fabaceae):** Meadow vetchling, vetches.

**Carrot family (Apiaceae):** Wild angelica.

**Other dicotyledons:** Bell heather, bilberry, black nightshade, bladderworts, bluebell, cleavers, common orache, cowberry, creeping buttercup, creeping cinquefoil, creeping forget-me-not, cross-leaved heath, devil's-bit scabious, fairy flax, foxglove, germander speedwell, harebell, heath bedstraw, henbit dead-nettle, honeysuckle, lesser stitchwort, lousewort, meadow buttercup, milkworts, opium poppy, roses, round-leaved crowfoot, scarlet pimpernel, spotted spurge, thorn-apple, tormentil, wall speedwell, wild thyme, yellow-rattle.

## Aquatic species

### Susceptible:

**Pteridophytes:** Water horsetail.

**Grasses:** Floating sweet-grass.

**Other monocotyledons:** Bog pondweed, pondweeds.

### Moderately susceptible:

**Monocotyledons:** Water hyacinth.

**Daisy family (Asteraceae):** Marsh thistle.

**Other dicotyledons:** Yellow water-lily.

## Asulam. Cont...

### Moderately resistant:

**Dicotyledons:** Marsh lousewort, marsh speedwell, marsh St John's-wort, water milfoils.

### Resistant:

**Mosses:** *Fontinalis antipyretica*.

**Monocotyledons:** Bog asphodel, duckweeds, marsh arrowgrass.

**Dicotyledons:** Bog pimpernel, bogbean, bog-myrtle, common marsh-bedstraw, common water-crowfoot, marsh cinquefoil, marsh-marigold, marsh pennywort, marsh violet, marsh willowherb.

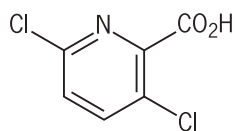
### Livestock withholding period

Normally – at least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Aventis CropScience. Asulox product label.  
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# Clopyralid

(eg *Dow Shield*; solution, concentrate)

## Summary

Clopyralid is a selective, post-emergent, systemic, pyridine herbicide available as a single active product or as a mixture with other actives (eg with triclopyr as *Grazon 90*). It is absorbed by leaves and roots with translocation both acropetally (up) and basipetally (down). Clopyralid (and its salts) is very water soluble but it has been found not to leach in the field. It is not toxic to mammals and other wildlife and not expected to adversely impact soil and aquatic fauna. Care should be taken when applying near to watercourses.

## Application scenarios

Clopyralid is registered for the control of a variety of annual and perennial dicotyledons, including corn marigold and **especially creeping thistle**, in established grassland, non-crop land and ornamentals<sup>1</sup>. Treatments are only effective when the weeds are actively growing and most uses require application prior to flowering (June-August)<sup>2</sup>. Application can be by tractor-mounted sprayer or hand-operated, knapsack sprayer; or by weed-wipe (off-label) for some formulations (eg *Dow Shield* and *Grazon 90*). Weedwiping – apply at full stem extension but before flowering.

## Fate in soil

Clopyralid is known to degrade moderately quickly in soil, through microbial action, in aerobic soil systems (DT<sub>50</sub> field values ranging from 8–66 days)<sup>3</sup>. Clopyralid is very water soluble (143 g l<sup>-1</sup>)<sup>3</sup> and is not bound tightly to soil (K<sub>oc</sub> range of 0.4–12.9)<sup>3</sup>. However, a range of studies under field conditions have demonstrated that clopyralid does not constitute a risk to groundwater<sup>4</sup>.

## Fate in water

Clopyralid does not appear to be susceptible to hydrolysis, but no information is available on its fate in water.

Its low logK<sub>ow</sub> value (-2.63 at pH7)<sup>3</sup> indicates that there will be no significant binding to sediments and low bioaccumulation potential in aquatic species (eg fish).

## Effects on terrestrial fauna

Generally, clopyralid is regarded as moderately toxic<sup>3</sup> with an oral LD<sub>50</sub> in the rat of around 3,000 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >0.38 mg l<sup>-1</sup>. It does not cause skin

sensitisation but some formulations can be very irritating to the eye<sup>3,4</sup>. The risk to birds is considered low (oral LD<sub>50</sub> for ducks 1,465 mg kg<sup>-1</sup>)<sup>3</sup> and clopyralid is non-toxic to bees (LD<sub>50</sub> >100 mg per bee)<sup>3</sup>. There are no adverse effects reported for worms (LC<sub>50</sub> (14days) >1,000 mg kg<sup>-1</sup> soil)<sup>3</sup> nor for soil microbial processes<sup>3</sup>.

## Effects on aquatic fauna

Clopyralid is moderately toxic to fish (LC<sub>50</sub> around 100 mg l<sup>-1</sup>)<sup>3</sup> and slightly toxic to water fleas (acute EC<sub>50</sub> 225 mg l<sup>-1</sup>)<sup>3</sup>. It is more toxic to algae (eg *Selenastrum capricornutum* EC<sub>50</sub> 7.3 mg l<sup>-1</sup>)<sup>3</sup>. Given its high potential for mobility in soil, care should be exercised when applying near to watercourses.

## Effects on non-target plants

Clover is sensitive to clopyralid and application should not be made within the root zone of species of the daisy (Asteraceae) family (eg yarrows, thistles, centaury, hawk's-beards, hawkweeds, cat's-ears, oxtongues, ragworts) or pea family (eg brooms, greenweeds, peas, medicks, gorse, vetches).

Aquatic plants are thought to be only moderately susceptible to clopyralid (eg fat duckweed EC<sub>50</sub> (14 days) 89 mg l<sup>-1</sup>)<sup>3</sup>.

## Efficacy/safety<sup>2,5,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Autumn hawkbit, cat's-ears, cocklebur, corn marigold, hawk's-beards, cudweed, dandelion, goat's-beard, greater knapweed, groundsel, hawkweeds, knapweeds, mouse-ear-hawkweeds, ox-eye daisy, oxtongues, pineappleweed, ragworts, scented mayweed, scentless mayweed, smooth sow-thistle, sunflower, yellow star-thistle, thistles, yarrows.

**Pea family (Fabaceae):** Brooms, gorses, greenweeds, medicks, melilots, peas, vetches, white clover.

**Other dicotyledons:** Docks (seedlings), ribwort plantain, summer-cypress.

#### Moderately susceptible:

**Daisy family (Asteraceae):** Canadian fleabane, colt's-foot, perennial sow-thistle, prickly lettuce.

**Cabbage family (Brassicaceae):** London-rocket, shepherd's purse.

**Other dicotyledons:** Amphibious bistort (young plants), black bindweed, black nightshade, chickweed, docks, Japanese-lantern, knotweeds, leafy-fruited nightshade, stork's-bills, thorn-apples, white clover.

#### Moderately resistant:

**Grasses:** Cock's-foot, upright brome.

**Dicotyledons:** Black horehound, common dog-violet, common mallow, common toadflax, creeping cinquefoil, dog's mercury, early dog-violet, field bindweed, foxglove, lady's bedstraw, pale persicaria, redshank, primrose, wood avens.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow-grass, autumn millet, beetle-grass, Bermuda-grass, canary-grass, cocksbur, drooping brome, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, ripgut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

**Other monocotyledons:** Galingales.

**Cabbage family (Brassicaceae):** Cabbage/rape, dittander, swine-cresses, wild radish.

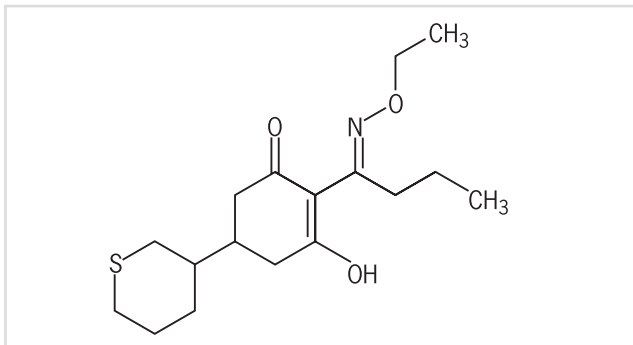
**Other dicotyledons:** Amaranths, annual morning-glory, common fiddleneck, fat-hen, henbit dead-nettle, knotgrasses, mallows, morning glory, nettle-leaved goosefoot, pigweed, procumbent yellow-sorrel, ribwort plantain, velvetleaf.

#### Livestock withholding period

Normally – at least 7 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
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([www.dowagro.co.uk](http://www.dowagro.co.uk)).
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- (6) Marshall, E J P., & Craine, Y., cited in Breeze V G., Marshall E J P., Hart, A., Vickery J A., Crocker, J., Walters, K., Packer, J., Kendall, D., Fowbert, J., & Hodkinson, D. 1999. *Assessing pesticide risks to non-target terrestrial plants. A desk study*. MAFF Pesticides Safety Directorate.



## Cycloxydim

(eg Laser; emulsifiable concentrate)

### Summary

Cycloxydim is a selective, systemic, post-emergent, cyclohexanedione herbicide; available as a single active product. It is rapidly absorbed by foliage, with translocation both acropetally (up) and basipetally (down). The active component is water-soluble and only weakly bound to soil. However, it is rapidly degraded in soil and not expected to leach. Cycloxydim is of low toxicity generally (but the formulated product is an eye and skin irritant), and not expected to adversely impact soil and aquatic fauna. Nevertheless, every effort should be made to avoid direct contamination of watercourses.

### Application scenarios

Cycloxydim is registered for the control of annual and perennial grass weeds in forestry and grassland temporarily removed from production<sup>1</sup>. Optimum control is achieved when weeds are still small and are actively growing<sup>2</sup>. Application can be at any time. In forestry uses trees should be established before treatment with cycloxydim. Application can be by tractor-mounted sprayer or hand-operated knapsack<sup>2</sup>.

### Fate in soil

Cycloxydim is known to degrade fast in aerobic soil systems (DT<sub>50</sub> values ranging from 1–12 days in the laboratory)<sup>4</sup>. It is fairly water soluble (38 mg kg<sup>-1</sup>)<sup>4</sup> and is not bound tightly to soil (K<sub>oc</sub> values range from 5–183)<sup>4</sup>. Therefore, there is a risk of leaching and movement to surface water via run-off and drainage (especially immediately following application), but this risk is expected to be low, and to decrease rapidly with time after application, due to the fast degradation in soil. Cycloxydim is also expected to degrade in soil through the action of sunlight<sup>4</sup>.

### Fate in water

Cycloxydim is hydrolysed faster at lower pH values (DT<sub>50</sub> 7 days at pH 5) than at higher pH values (DT<sub>50</sub> around 100 days at pH > 7)<sup>4</sup> and is expected to be hydrolysed faster in the presence of sunlight. It has a low log<sub>KOW</sub> value (1.2 at pH 7)<sup>4</sup> and as such has a low potential to bioaccumulate.

### Effects on terrestrial fauna

Generally, cycloxydim is regarded as being of low mammalian toxicity<sup>4</sup>, with an acute oral LD<sub>50</sub> in the rat of >5,000 mg kg<sup>-1</sup><sup>3</sup>. It does not cause skin sensitisation but

the formulation is irritating to the eye and the skin<sup>4</sup>. The risk to birds is considered very low (oral LD<sub>50</sub> for ducks >2,000 mg kg<sup>-1</sup>)<sup>4</sup> and cycloxydim is non-toxic to bees (LD<sub>50</sub> >100 mg per bee)<sup>3</sup>. The formulated product is more toxic to earthworms (LC<sub>50</sub> of 86 mg kg<sup>-1</sup>) than cycloxydim itself (LC<sub>50</sub> 1,100 mg kg<sup>-1</sup>)<sup>4</sup>. Little or no effect is expected on soil microbial processes<sup>4</sup>.

### Effects on aquatic fauna

Cycloxydim has been found to be of low toxicity to fish (LC<sub>50</sub> 96h trout 220 mg l<sup>-1</sup>)<sup>3</sup> and of low toxicity to water fleas (acute LC<sub>50</sub> 132 mg l<sup>-1</sup>)<sup>3</sup>. Cycloxydim is more toxic to algae (eg *Chlorella fusca* EC<sub>50</sub> 32 mg l<sup>-1</sup>)<sup>4</sup>.

### Effects on non-target plants

Application of cycloxydim will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants, although data on aquatic species' sensitivities are not available. Treatment to very young trees could result in adverse effects, where the plants are not fully established<sup>2</sup>.

### Efficacy/safety<sup>2</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Oats (cultivated & wild) (susceptible at 150 g ha<sup>-1</sup>); barren brome, black-grass, canary-grass, Italian rye-grass, loose silky-bent, perennial rye-grass, soft brome (at 200 g ha<sup>-1</sup>); volunteer wheat (at 250 g ha<sup>-1</sup>).

#### Moderately susceptible:

**Grasses:** Black bent (susceptible at 400 g ha<sup>-1</sup>); common couch, creeping bent, onion couch (at 450 g ha<sup>-1</sup>).

#### Moderately resistant:

**Grasses:** Rough meadow-grass.

#### Resistant:

**Grasses:** Annual meadow-grass, red fescue.

**Trees & shrubs:** Ash, beech, oak, poplar, sweet chestnut, sycamore, wild cherry, willow.

**Conifers:** Corsican pine, Douglas fir, Japanese larch, lodgepole pine, noble fir, Scots pine, Sitka spruce, western red cedar.

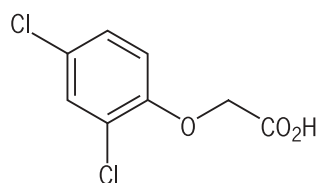
#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) BASF plc. Laser product label.  
([www.agricentre.co.uk](http://www.agricentre.co.uk)).
- (3) Tomlin, C D S. 2000. *The pesticide manual*.  
A world compendium. 12th edition. BCPC, Surrey, UK.
- (4) Evaluation on Cycloxydim; UK-PSD, 1990.





## 2,4-D

(eg *Dormone* or *Headland Staff*,  
soluble concentrates)

### Summary

2,4-D is a selective, post-emergent, systemic, phenoxyacetic acid herbicide; available as a single active product or in mixtures. In products it can be present as the acid, as a salt, ester or amine. Salts are readily absorbed by the roots, whereas esters are readily absorbed by foliage, followed by translocation. The solubility and aquatic toxicity of the active ingredient in the product can vary significantly, depending on the form of 2,4-D present. 2,4-D degrades rapidly in most matrices. For terrestrial uses, direct contamination of watercourses should be carefully avoided. When used in aquatic situations, strict adherence to all statutory requirements is especially important, to avoid unacceptable adverse impacts.

### Application scenarios

2,4-D is used for the control of annual and perennial broadleaved, woody and aquatic weeds in established grassland, orchards, conifer plantations, forestry and aquatic situations<sup>1,2</sup>. Weeds should be actively growing at application. Annual weeds are most susceptible at the seedling stage and perennial weeds when the flower buds are forming<sup>2</sup>. Treatment in aquatic situations should be when weeds are actively growing – between May and September. Application is as a foliar spray, using tractor-mounted spraying equipment or knapsacks and other hand-held sprayers.

### Fate in soil

2,4-D is known to degrade rapidly in soil with DT<sub>50</sub> values typically <7 days<sup>3</sup>. When present as an acid-derivative, the active form is rapidly degraded to the acid in soil. 2,4-D is very soluble in water (23 g l<sup>-1</sup>)<sup>3</sup>, whereas 2,4-D-esters tend to be sparingly soluble in water. Strength of soil binding is moderate (K<sub>oc</sub> value of 60)<sup>3</sup>. Although 2,4-D is regarded as potentially mobile, its fast degradation and application timing reduces the likelihood of contamination of groundwater.

### Fate in water

2,4-D is degraded in natural water/sediment systems via biotic processes with DT<sub>50</sub> values between one and several weeks<sup>5</sup>. 2,4-D has a very low LogK<sub>ow</sub> (0.04-0.33)<sup>3</sup>, indicating a very low bioaccumulation potential.

### Effects on terrestrial fauna

Generally, 2,4-D is regarded as moderately toxic<sup>3,5</sup> with rats having an acute oral LD<sub>50</sub> of 639-764 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> of 1,500 mg kg<sup>-1</sup> and acute inhalation LC<sub>50</sub> of >1.79 mg l<sup>-1</sup>. It is classified as a skin and eye irritant<sup>3</sup>. 2,4-D is non-toxic to birds (oral LD<sub>50</sub> for ducks >1,000 mg kg<sup>-1</sup>)<sup>3</sup> and to bees (oral LD<sub>50</sub> 11.5 mg per bee)<sup>5</sup>. It is not harmful to worms (LD<sub>50</sub> 7days 860 mg kg<sup>-1</sup>)<sup>3</sup>. 2,4-D-derivatives have similar toxicities to the acid.

### Effects on aquatic fauna

2,4-D has been found to be of low toxicity to aquatic fauna, with fish LC<sub>50</sub> values of >100 mg l<sup>-1</sup><sup>3</sup> and water flea LC<sub>50</sub> 21 days of 235 mg l<sup>-1</sup><sup>3</sup>. However, 2,4-D-derivatives can be more toxic in the aquatic environment than the parent acid, with fish and water flea LC<sub>50</sub> values being significantly lower (eg fish LC<sub>50</sub> for butoxyethanol-derivative: 0.65-3.3 mg l<sup>-1</sup><sup>4</sup>, water flea LC<sub>50</sub> for isooctylester-derivative: 0.5 mg l<sup>-1</sup><sup>4</sup>). 2,4-D is moderately toxic to algae (EC<sub>50</sub> 33.2 mg l<sup>-1</sup>)<sup>3</sup>.

### Effects on non-target plants

Application of 2,4-D will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to minimise such drift. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants. Where 2,4-D is used for control of aquatic species then very careful adherence to good practice is required.

### Efficacy/safety<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, dandelion (seedling stage), groundsel, prickly lettuce, smooth sow-thistle, sunflower, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, London-rocket, shepherd's purse, wild radish.

**Other dicotyledons:** Annual morning glory, black nightshade, thorn-apples, common poppy, common purslane, corn buttercup, fat-hen, hairy nightshade, Japanese-lantern, nettle-leaved goosefoot, purslane, small nettle, stork's-bills, summer-cypress, velvetleaf.

#### Moderately susceptible:

**Daisy family (Asteraceae):** Autumn hawkbit, creeping thistle, cudweed, dandelion, pineappleweed, prickly sow-thistle.

**Cabbage family (Brassicaceae):** Swine-cress.

**Other dicotyledons:** Amaranths, black bindweed, black nightshade, common fumitory, common orache, common nettle, creeping buttercup, field bindweed, fiddleneck, field forget-me-not, henbit dead-nettle, knotgrasses, knotweeds, mallows, medicks, melilots, pale persicaria, plantains, procumbent yellow-sorrel, redshank, ribwort plantain, scarlet pimpernel, shepherd's needle.

#### Moderately resistant:

**Daisy family (Asteraceae):** Common knapweed, colt's-foot, corn chamomile, creeping thistle, daisy, dandelion, dwarf thistle, perennial sow-thistle, scentless mayweed, spear thistle, yarrow.

**Other dicotyledons:** Bulbous buttercup, common chickweed, common nettle, common sorrel, corn spurrey, docks, meadow buttercup, meadow sorrel, meadowsweet, self-heal, sheep's sorrel.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow-grass, autumn millet, Bermuda-grass, beetle-grass sp., drooping brome, canary-grass, cockspur, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, riggut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

**Other monocotyledons:** Galingales.

**Cabbage family (Brassicaceae):** Dittander, swine-cresses.

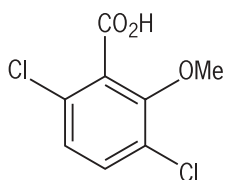
**Other dicotyledons:** Dodder, swine-cress.

#### Livestock withholding period

Normally – at least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Headland Agrochemicals UK Ltd. *Headland Staff* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) 2,4-D Herbicide Profile 9/88.  
(<http://pmep.cce.cornell.edu/profiles/herb-growthreg>).
- (5) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (6) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



### Summary

Dicamba is a selective, post-emergent, benzoic acid herbicide, available as a single active product or as a mixture with other actives. It is readily absorbed by the leaves and roots and translocated throughout the plant via both the symplastic and apoplastic systems. Dicamba (and its salts) is very water-soluble and may constitute a risk to groundwater under some circumstances. It is not toxic to mammals and other wildlife and not expected to adversely impact soil and aquatic fauna.

### Application scenarios

Dicamba is registered for the control of a variety of annual and perennial broad-leaved weeds in established grassland and grass leys, and (when in mixtures with other actives, eg MCPA and mecoprop) forestry, amenity grass and non-crop land<sup>1</sup>. Treatments are only effective when the weeds are actively growing and dry at time of application<sup>3</sup>. Application can be from early spring to mid-October, and will usually be by tractor-mounted sprayer.

### Fate in soil

Dicamba is known to degrade moderately quickly in soil, through microbial action. When soil conditions are optimal (i.e. moist), DT<sub>50</sub> values are <14 days, but can be much longer (typically between 1 and 4 weeks)<sup>5</sup>. Dicamba is water-soluble (6.1 g l<sup>-1</sup>)<sup>4</sup> and is not bound tightly to soil (K<sub>oc</sub> value of 2)<sup>4</sup>. Consequently, under some circumstances (for late applications with very wet conditions following application), leaching of dicamba into groundwater may occur.

### Fate in water

Dicamba is not susceptible to chemical hydrolysis, volatilisation or adsorption to sediments, but is degraded microbially in natural water systems<sup>5</sup>. Its low logK<sub>ow</sub> value (-1.88 at pH7)<sup>4</sup> indicates that there will be no significant binding to sediments and low bioaccumulation potential in aquatic species (eg fish).

### Effects on terrestrial fauna

Generally, dicamba is regarded as of low mammalian toxicity<sup>5</sup> with an oral LD<sub>50</sub> in the rat of 757-1,707 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >200 mg l<sup>-1</sup>. It may cause skin irritation and is believed to be very irritating and corrosive to the eye<sup>4,5</sup>. Dicamba is non-carcinogenic,

## Dicamba

(eg *Cadence*; water-soluble granule.

Mixtures: eg *Banlene Super*; soluble aqueous concentrate)

non-genotoxic and not a teratogen. The risk to birds is considered low (oral LD<sub>50</sub> for ducks 2,000 mg kg<sup>-1</sup>)<sup>3</sup> and dicamba is non-toxic to bees<sup>4</sup>.

### Effects on aquatic fauna

Dicamba has been found to be of low toxicity to fish (LC<sub>50</sub> around 130 mg l<sup>-1</sup>)<sup>3</sup> and low toxicity to water fleas (LC<sub>50</sub> 48 hours 110 mg l<sup>-1</sup>)<sup>3</sup>. Dicamba would be expected to be more toxic to algae, but no data are available.

### Effects on non-target plants

Dicotyledons are generally sensitive to dicamba.

When applying around trees, drift onto foliage should be avoided<sup>3</sup>.

No information is available with regard to risks to aquatic plants. Consequently, a precautionary approach should be taken and care exercised when applying dicamba close to natural watercourses.

### Efficacy/safety<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, dandelion (seedlings), daisy, groundsel, prickly lettuce, smooth sow-thistle, sunflower, thistles, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, garden radish, London-rocket, shepherd's purse.

**Pea family (Fabaceae):** Clover, medicks, melilots.

**Other dicotyledons:** Amaranths, annual morning glory, black nightshade, buckwheats, common chickweed, common purslane, docks (seedlings), fat-hen, fiddleneck, Japanese-lantern, knotgrasses, knotweeds, leafy-fruited nightshade, nettle-leaved goosefoot, pigweed, ribwort plantain (seedlings), stork's-bills, summer-cypress, thorn-apples, velvetleaf.

#### Moderately susceptible:

**Daisy family (Asteraceae):** Cudweed, dandelion, pineappleweed.

**Cabbage family (Brassicaceae):** Dittander, swine-cresses.

**Other dicotyledons:** Common nettle, docks, field bindweed, henbit dead-nettle, mallows, procumbent yellow-sorrel, ribwort plantain.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow-grass, autumn millet, cockspur, beetle-grass sp., Bermuda-grass, canary-grass, drooping brome, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, riggut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

**Other monocotyledons:** Galingales.

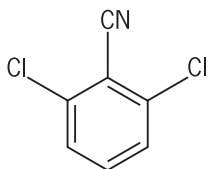
**Dicotyledons:** Dodder.

#### Livestock withholding period

Normally – at least 21 days and until foliage of poisonous weeds such as ragwort and buttercup have died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Barclay Chemicals Ltd. *Cadence* product label.
- (3) Aventis CropScience. Banlene Super product label.  
([www.aventis.co.uk](http://www.aventis.co.uk)).
- (4) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (5) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (6) *Weed susceptibility* chart, University of California, Co-operative Extension program, Ed. D Cudney (2000).



## Dichlobenil

(eg *Casoron G granules, Luxan Dichlobenil Granules*)

Dichlobenil is a selective or non-selective nitrile herbicide (depending on application rate). It is used for pre-emergent and post-emergent control of a range of annual and perennial broad-leaved weeds and grasses, and aquatic weeds in shallow water bodies. It has low mammalian toxicity, moderate toxicity to aquatic fauna and high toxicity to aquatic flora. Dichlobenil is volatile and only moderately adsorbed to soil and sediments. It can be persistent in soil and has a moderate risk of leaching. Its main soil metabolite has a more significant risk of leaching. When used in aquatic situations, strict adherence to all statutory requirements is especially important, to avoid unacceptable adverse impacts.

### Application scenarios

Dichlobenil is registered for the pre- and post-emergence control of a range of annual and perennial broad-leaved weeds and grasses in established apples and pears, soft fruit and specified woody ornamentals. It is also approved for total vegetation control in non-crop areas and for aquatic weed control (where the flow rate does not exceed 90 metres per hour)<sup>1,2</sup>. For selective applications, treatment should be made to moist soils, ideally before the end of winter, to achieve the maximum residual activity. Best results will be achieved under cool conditions, particularly if rain falls soon after treatment. Residual activity is reduced if application is made under warmer conditions. Dichlobenil granules can be applied using a suitable hand-held or mechanical spreader. It should only be applied to crops that have been established for at least two years before application. For total weed control on non-cropped areas, treatment should be made in February-March, to give up to 12 months control of susceptible species<sup>2</sup>.

For aquatic weed control, application should be made in early spring (March-May), when active growth commences; by hand, motorised knapsack spreader or other mechanical applicators, directly to the water surface<sup>2</sup>.

### Fate in soil

Dichlobenil degrades slowly in soil (aerobic DT<sub>50</sub> values of 1-6 months)<sup>3</sup>, to give a major soil metabolite (BAM), and even more slowly under anaerobic conditions and in sediments of ponds and rivers (DT<sub>50</sub> values of up to 2.8 years)<sup>4</sup>. It has a low water solubility (14.6 mg l<sup>-1</sup>), and is only moderately bound to soil and sediment (K<sub>oc</sub> range of 49-323, mean 178)<sup>4</sup>. BAM has been found to be more

mobile than dichlobenil (which itself has a moderate risk of leaching to groundwater). Given the persistence and mobility of dichlobenil and BAM there is a risk that both could contaminate surface water.

### Fate in water

Dichlobenil is not hydrolysed but is thought to be degraded through the action of sunlight<sup>3</sup>. The most significant dissipation route for dichlobenil in water systems is thought to be its volatility (DT<sub>50</sub> from aquatic systems found to vary from 2.4 to 69 days)<sup>4</sup>. Dichlobenil has a logK<sub>ow</sub> value of 2.70<sup>3</sup>, which indicates a low potential for bioaccumulation in aquatic species (eg fish).

### Effects on terrestrial fauna

Generally, dichlobenil is regarded as slightly toxic to mammals<sup>3,4</sup> - with an oral LD<sub>50</sub> in the rat of 4,460 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >250 mg m<sup>-3</sup>. It is not irritating to the eye<sup>3</sup>, and not irritating to the skin<sup>4</sup>. Dichlobenil is slightly toxic to birds (oral LD<sub>50</sub> for ducks >5,200 mg kg<sup>-1</sup> and 1,500 mg kg<sup>-1</sup> for ring-necked pheasant)<sup>4</sup> and is non-toxic to bees (contact LD<sub>50</sub> >11 mg per bee)<sup>3</sup> and worms (LD<sub>50</sub> >1,000 mg kg<sup>-1</sup>)<sup>3</sup>. Generally, BAM is less than, or as toxic as, dichlobenil<sup>4</sup>.

### Effects on aquatic fauna

Dichlobenil is moderately toxic to fish (LC<sub>50</sub> 96 hours of 5-13 mg l<sup>-1</sup>)<sup>3</sup>, water fleas (LC<sub>50</sub> 48 hours 6.2 mg l<sup>-1</sup>)<sup>3</sup> and algae (EC<sub>50</sub> for *Selenastrum capricornutum* 2.0 mg l<sup>-1</sup>)<sup>3</sup>. BAM is significantly less toxic than dichlobenil to water fleas (EC<sub>50</sub> 856 mg l<sup>-1</sup>)<sup>4</sup> and fish (LC<sub>50</sub> of 140 mg l<sup>-1</sup>)<sup>4</sup>. Excessive decaying vegetation, following successful treatment in aquatic areas, can lead to oxygen depletion and indirect adverse effects on fish, and other aquatic fauna, and measures should be taken to prevent such a situation from occurring.

When applied in aquatic situations, given the moderate toxicity to aquatic species, it is especially important to ensure strict adherence to all statutory requirements, to avoid unacceptable adverse impacts.

### Effects on non-target plants

Dichlobenil is toxic to a wide variety of aquatic plants. When not applying directly to water bodies it is important to consider the possible movement of dichlobenil through the soil to water bodies, and the movement to roots of

non-target susceptible plants. In addition, due to the soil persistence of dichlobenil, sufficient time should elapse before re-planting is attempted. It has also been found that some conifers are susceptible to dichlobenil vapour<sup>3</sup>.

#### Efficacy/Safety<sup>2,5</sup>

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Terrestrial species

##### Susceptible:

**Ferns:** Bracken.

**Other pteridophytes:** Field horsetail, horsetail spp.

**Grasses:** Annual meadow-grass, blackgrass, canary-grass, cock's-foot, common couch, drooping brome, rough meadow-grass, rye-grass, creeping soft-grass, sandburs, smooth meadow-grass, volunteer cereals, wild oat.

**Conifers:** Larch.

**Other trees & shrubs:** Alder buckthorn, elder, honey locusts, snowberry.

**Daisy family Asteraceae):** Colt's-foot, corn marigold, cudweed, dandelion (seedlings), groundsel, scentless mayweed, pineappleweed, prickly lettuce, smooth sow-thistle, stinking chamomile, thistle, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, charlock, creeping yellow-cress, garden radish, hedge mustard, hoary cress, London-rocket, shepherd's purse.

**Other dicotyledons:** Annual mercury, annual morning glory, black bindweed, black nightshade, chickweed, cleavers, common mallow, common mouse-ear, common nettle, common orache, common purslane, corn spurrey, docks (seedlings), dodder, fat-hen, fiddleneck, ground elder, henbit dead-nettle, Japanese-lantern, knotgrass, leafy-fruited nightshade, mallows, nettle-leaved goosefoot, plantain, poppy, procumbent yellow-sorrel, redshank, shepherd's-purse, small nettle, speedwell, willowherb.

#### Dichlobenil. Cont...

##### Moderately susceptible:

**Grasses:** Cockspur, finger-grasses, stink-grass, sweet vernal-grass.

**Other monocotyledons:** Club-rush, common reed, common spike-rush, galingales, sedge, toad rush.

**Daisy family Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, hemp agrimony, mugwort, wormwood.

**Pea family (Fabaceae):** Black medick, clover, lucerne, medicks, melilots.

**Cabbage family (Brassicaceae):** Perennial wall rocket.

**Other dicotyledons:** Amaranths, buttercup, cinquefoil, field bindweed, hedge bindweed, ribwort plantain, silverweed, stork's-bills.

##### Moderately resistant:

**Grasses:** Bermuda-grass, hairy finger-grass.

**Conifers:** Pine, spruce.

**Other trees & shrubs:** Ash, bamboo, beech, burberis, birch, butterfly-bush, cherry, cotoneaster, crab apple, currant, Deutzia, dogwood, escallonia, spindle, forsythia, hawthorn, bladder ketmia, holly, hydrangea, Japanese laurel, laburnum, lilac, oak, pear, mock-oranges, privet, rhododendron (including azaleas), rowan, brideworts, sycamore, tamarisk, viburnums, honeysuckle Weigela sp., willow.

**Daisy family (Asteraceae):** Dandelions.

**Other dicotyledons:** Docks, heaths, pigweed.

##### Resistant:

**Grasses:** Johnson-grass.

**Cabbage family (Brassicaceae):** Dittander.

**Dicotyledons:** Bramble, crane's-bill, hogweed, hop, nightshade, small scabious.



## Aquatic species

### Susceptible:

**Mosses:** Willow moss.

**Pteridophytes:** Marsh horsetail, water horsetail.

**Grasses:** Floating sweet-grass.

**Other monocotyledons:** Arrowhead, Canadian waterweed, curled pondweed, fennel pondweed, frogbit, horned pondweed, ivy-leaved duckweed, water-soldier.

**Dicotyledons:** Common water-starwort, mare's-tail, rigid hornwort, water-milfoil, water-crowfoot, water dock, water-violet.

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### Moderately susceptible:

**Monocotyledons:** Broad-leaved pond-weed, water plantain.

**Dicotyledons:** Lesser water parsnip, water-cress, water dropworts.

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### Moderately resistant:

**Monocotyledons:** Branched bur-reed, shining pondweed.

**Dicotyledons:** Amphibious bistort, white water-lily, yellow water-lily.

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### Resistant:

**Algae:** Filamentous algae.

**Grasses:** Common reed, reed canary-grass.

**Other monocotyledons:** Bulrush, common club-rush, common duckweed, flowering-rush, sedges, yellow iris, soft-rush.

**Dicotyledons:** Marsh marigold.

## Dichlobenil. Cont...

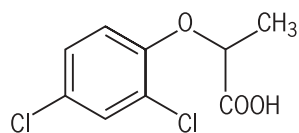
### Livestock withholding period

Normally – none quoted. Check the label.

### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Luxan Dichlobenil Granules product label, Luxan (UK) Ltd.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) US-EPA RED document, EPA 738-R-98-003 (1998) ([www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm)).
- (5) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).





### Summary

Dichlorprop is a selective, systemic, post-emergent, phenoxypropionic herbicide. Herbicides containing dichlorprop alone are approved only for use on cereal crops. However, a mixture with MCPA is approved for the control of dicotyledons in amenity grass. It is absorbed by foliage, with translocation to the roots. Dichlorprop can be as the parent acid, ester or as the potassium-salt. The parent/salt is water-soluble and only weakly bound to soil. However, it is rapidly degraded in soil and not expected to leach. Dichlorprop is of low toxicity generally and not expected to adversely impact soil and aquatic fauna (but the ester forms are more toxic to aquatic fauna). Nevertheless, every effort should be made to avoid direct contamination of watercourses.

### Application scenarios

Dichlorprop is registered for the post-emergent control of annual and perennial broad-leaved weeds in amenity grassland (managed)<sup>1</sup>. Application should be between late spring and early autumn when the grass is actively growing<sup>2</sup>. Application can be by tractor-mounted sprayer or hand-operated knapsack.

### Fate in soil

Dichlorprop is known to degrade relatively quickly in aerobic soil systems (DT<sub>50</sub> values of about 21-25 days)<sup>3</sup>. The parent acid is water soluble (350 mg l<sup>-1</sup>)<sup>3</sup> with the salt being very soluble (900 g acid equivalents per litre)<sup>3</sup> and is not bound tightly to soil (K<sub>oc</sub> values range from 12-40)<sup>3</sup>. Therefore, there is a risk of leaching and movement to surface water via run-off and drainage (especially immediately following application), but this risk is expected to be low, and to decrease rapidly with time after application due to the fast degradation in soil.

### Fate in water

Dichlorprop parent acid is largely dissociated in water (pK<sub>a</sub> of 3.0)<sup>3</sup> and would be expected to have a low logK<sub>ow</sub> at pH7 and, as such, has a low potential to bioaccumulate. However, dichlorprop is believed to be very stable in water<sup>3</sup>.

## Dichlorprop

eg *SHL Turf Feed and Weed* (dichlorprop + MCPA); granule

**NB:** This herbicide is withdrawn from sale on 24 July 2003 and last day of use is 31 December 2003, as a result of the EC review of approved pesticides. The manufacturer has not supported its continued use.

### Effects on terrestrial fauna

Generally, dichlorprop is regarded as being of low mammalian toxicity<sup>3</sup> but is an eye and skin irritant<sup>3</sup>. In the rat it has an acute oral LD<sub>50</sub> of 825 mg kg<sup>-1</sup> and an inhalation LC<sub>50 4hours</sub> of >0.65 mg l<sup>-1</sup><sup>3</sup>. The risk to birds is low (LD<sub>50</sub> for quail 504 mg kg<sup>-1</sup>)<sup>3</sup> and dichlorprop is non-toxic to bees<sup>3</sup>. Dichlorprop is not toxic to earthworms (LC<sub>50</sub> >1,000 mg kg<sup>-1</sup>)<sup>3</sup>.

### Effects on aquatic fauna

Dichlorprop parent acid/salt have been found to be of low toxicity to fish (LC<sub>50 96h</sub> trout 521 mg l<sup>-1</sup>)<sup>3</sup> and of low toxicity to water fleas (LOEC<sub>survival</sub> 100 mg l<sup>-1</sup>)<sup>3</sup>. However, the esters of dichlorprop are much more toxic to aquatic fauna (eg dichlorprop-butyl LC<sub>50 48 hour</sub> of 1.1 mg l<sup>-1</sup> for bluegill sunfish)<sup>3</sup>. Dichlorprop is not toxic to algae (eg freshwater green algae ErC<sub>50</sub> 1,100 mg l<sup>-1</sup>)<sup>3</sup>.

### Effects on non-target plants

Application of dichlorprop will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants, although data on aquatic species' sensitivities are not available.

### Efficacy/safety<sup>4</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible (at 1,400 g ha<sup>-1</sup>):

**Daisy family (Asteraceae):** Creeping thistle.

**Cabbage family (Brassicaceae):** black mustard, charlock, field pennycress (seedlings), oilseed rape, shepherd's-purse, treacle mustard, wild radish, wild turnip (seedlings).

**Knotweed family (Polygonaceae):** Black bindweed, broad-leaved dock (seedlings), curled dock, pale persicaria, redshank.

**Other dicotyledons:** Common orache (seedlings), corn buttercup (seedlings), cleavers, common chickweed, fat-hen small nettle.

**Note:** All of the above species are susceptible as young plants only, or as seedlings only (where specified).

#### Moderately susceptible (at 1,400 g ha<sup>-1</sup>):

**Pteridophytes:** Field horsetail.

**Daisy family (Asteraceae):** Groundsel.

**Other dicotyledons:** Black nightshade, common fumitory, common mouse-ear, common poppy, corn spurrey, dove's-foot cranesbill, hemp-nettle, knotgrass.

#### Moderately resistant (at 1,400 g ha<sup>-1</sup>):

**Daisy family (Asteraceae):** Scentless mayweed.

**Carrot family (Apiaceae):** Fool's parsley, shepherd's needle.

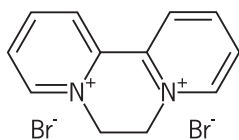
**Other dicotyledons:** Common field-speedwell, field pansy, forget-me-not, scarlet pimpernel.

#### Livestock withholding period

Normally – until foliage of poisonous weeds such as ragwort has died and become unpalatable.  
Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) William Sinclair Horticulture. Product information.  
([www.william-sinclair.co.uk](http://www.william-sinclair.co.uk))
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Headland Agrochemicals Ltd., *Headland Link*, product label.



### Summary

Diquat is a non-selective, post-emergent, quaternary ammonium, contact herbicide absorbed through the foliage with some translocation in the xylem. It is available as a single active product or as a mixture with paraquat. Despite being very water soluble, diquat binds very tightly to soil and sediments. It is moderately toxic to mammals and other wildlife but is very rapidly inactivated on contact with soil and plants and not expected to adversely impact on soil and aquatic fauna. When used in aquatic situations, strict adherence to all statutory requirements is especially important, to avoid unacceptable adverse impacts.

### Application scenarios

Diquat is registered for the control of weeds in forestry, non-crop areas, field margins, sward destruction in grasslands, and weeds in still or slow-moving water<sup>2,3</sup> or in fast-moving water (*Midstream*; specific formulation for use in water only). Treatments are effective when the weeds are actively growing in late spring and early summer. Land-based treatments can be made either by tractor-mounted spray systems or hand-held knapsack sprayers. Treatments for water weeds can be made as a surface spray for floating weeds (not *Midstream*), or by injecting below the surface for submerged weeds (*Midstream*). However, heavy infestations should be treated in strips with 14-21 days between applications, due to the indirect effects on fish that can arise. Applications should not be made to muddy waters.

### Fate in soil

Diquat is known to degrade only very slowly in soil, if at all. Diquat is extremely water soluble (700 g l<sup>-1</sup>)<sup>6</sup> but is also extremely tightly bound to soil (K<sub>oc</sub> value of >10,000)<sup>6</sup>. Consequently, diquat is completely immobile and will not move to groundwater. Once bound to soil, diquat has been found to be completely non-available (physically and biologically).

### Fate in water

Diquat is not susceptible to chemical hydrolysis or volatilisation. It does not bioaccumulate, but does bind very rapidly, and tightly, to sediment and particulate matter suspended in the water (soil, decaying vegetable matter).

## Diquat (dibromide)

eg *Reglone*; soluble concentrate or *PDQ* (diquat + paraquat); soluble concentrate

**NB:** A recent EC review report for diquat<sup>1</sup> concluded that aquatic weed control uses are no longer acceptable and instructed that authorisations for these uses must be withdrawn.

### Effects on terrestrial fauna

Generally, diquat is regarded as moderately toxic with an oral LD<sub>50</sub> in the rat of 408 mg kg<sup>-1</sup><sup>5</sup>, dermal LD<sub>50</sub> in the rabbit of 289 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of 0.97 mg l<sup>-1</sup><sup>4</sup>. It can cause skin irritation and is irritating to the eye<sup>4</sup>. Diquat is moderately toxic to birds (oral LD<sub>50</sub> for ducks 155 mg kg<sup>-1</sup>)<sup>5</sup> and non-toxic to bees (oral LD<sub>50</sub> 22 mg per bee)<sup>5</sup>. Diquat may be harmful to livestock<sup>3</sup>.

### Effects on aquatic fauna

Diquat has been found to be moderately toxic to fish (LC<sub>50</sub> around 39 mg l<sup>-1</sup>)<sup>5</sup> and highly toxic to water fleas (LC<sub>50</sub> 48hours 2.2 mg l<sup>-1</sup>)<sup>5</sup>. Decaying vegetation in water (killed by diquat treatment) may result in oxygen depletion, which can adversely affect populations of fish and other aquatic animals.

### Effects on non-target plants

Diquat is a non-selective herbicide and care should therefore be taken not to over-spray desirable, non-target plants and to reduce spray drift onto such plants.

Highly sensitive aquatic species include spiked water-milfoil, whorled water-milfoil, curled pondweed and common water-crowfoot. Each of these species has been reported as being susceptible to diquat concentrations in water of 0.5 ppm<sup>7,8</sup>.

### Efficacy/safety<sup>2,5,6,7</sup>

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

### Terrestrial species

#### Susceptible:

**Grasses:** Finger-grasses, yellow bristle-grass.

**Other monocotyledons:** Soft rush.

**Daisy family (Asteraceae):** Argentine fleabane, groundsel, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, London-rocket.

**Other dicotyledons:** Amaranths, black nightshade, chickweed, common purslane, docks (seedlings), fat-hen, garden radish, henbit dead-nettle, Japanese-lantern, leafy-fruited nightshade, London-rocket, nettle-leaved goosefoot, summer-cypress.

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**Moderately susceptible:**

**Grasses:** Annual meadow-grass, Bermuda-grass (seedlings), canary-grass, cocksbur, drooping brome, Italian rye-grass, Johnson-grass, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass.

**Daisy family (Asteraceae):** Canadian fleabane, cocklebur, pineappleweed, prickly lettuce, smooth sow-thistle, sunflower.

**Cabbage family (Brassicaceae):** Shepherd's purse, swine-creases.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Annual morning glory, common nettle, fiddleneck, field bindweed, knotgrass, procumbent yellow-sorrel, ribwort plantain, stork's-bills, thorn-apples, velvetleaf.

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**Resistant:**

**Pteridophytes:** Horsetails.

**Grasses:** Bermuda-grass, beetle-grass sp.

**Other monocotyledons:** Galingales.

**Daisy family (Asteraceae):** Cudweed, dandelion.

**Cabbage family (Brassicaceae):** Dittander.

**Other dicotyledons:** Docks (established plants), dodder, mallows.

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**Aquatic species (for information only)**

**Susceptible:**

**Algae:** *Cladophora* & *Hydrodictyon* spp.

**Pteridophytes:** Water fern.

**Grasses:** Branched bur-reed, unbranched bur-reed.

**Diquat (dibromide). Cont...**

**Other monocotyledons:** Arrowhead, broad-leaved pondweed, Canadian waterweed, curled pondweed, fennel pondweed, ivy-leaved duckweed, lesser pondweed, long-stalked pondweed, shining pondweed, small pondweed, water-plantain.

**Dicotyledons:** Common water-crowfoot/crowfoots, rigid hornwort, spiked water-milfoil, water-cress, whorled water-milfoil.

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**Moderately susceptible:**

**Monocotyledons:** Duckweeds, frogbit.

**Dicotyledons:** Water-starworts, water-violet.

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**Moderately resistant:**

**Algae:** *Chara*, *Rhizoclonium* & *Spirogyra* spp.

**Pteridophytes:** Water horsetail.

**Grasses:** Common reed, floating sweet-grass, reed sweet-grass.

**Other monocotyledons:** Bulrush, greater pond-sedge, lesser bulrush, yellow iris.

**Dicotyledons:** Amphibious bistort, fringed water-lily, mare's-tail, white water-lily, yellow water-lily.

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**Resistant:**

**Mosses:** *Fontinalis* spp.

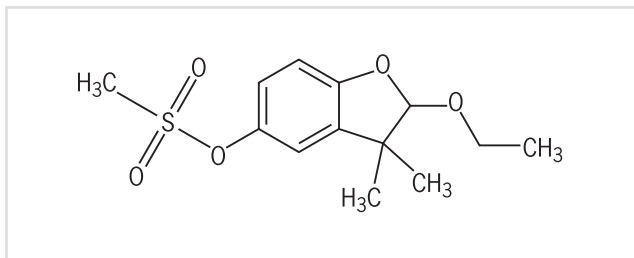
**Algae:** *Enteromorpha intestinalis*, *Vaucheria dichotoma*.

**Livestock withholding period**

Normally – keep livestock out for at least 24 hours and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

**References**

- (1) DG Health and Consumer Protection. 22 March 2001.
- (2) UK Pesticides Safety Directorate.  
[www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm).
- (3) Syngenta Ltd. *Reglone* product label.
- (4) US-EPA RED document, EPA 738-R-95-016 (1995).  
[www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm).
- (5) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (6) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).
- (7) Fryer, J D., & Makepeace, R J., (eds). 1978. *Weed control handbook*, Vol II. Recommendations.



### Summary

Ethofumesate is a selective, systemic, pre- and post-emergent, benzofuranyl alkylsulfonate herbicide, available as a single active product for use in grassland. It is absorbed by emerging shoots and roots and translocated to foliage. Ethofumesate is not readily absorbed by leaves after a mature cuticle has formed. Ethofumesate is weakly bound to soil, however, despite moderate degradation rates in soil it is not expected to leach, but movement to surface water is a possibility. (Some products<sup>2</sup> advise against use on sandy soils and soils with greater than 5% organic matter). Ethofumesate is of low mammalian toxicity and not expected to adversely impact soil fauna. However, ethofumesate has moderate toxicity to aquatic organisms and, therefore, every effort should be made to avoid contamination of watercourses.

### Application scenarios

Ethofumesate is registered for the pre- and post-emergent control of certain broad-leaved weeds and grass weeds in amenity grassland, established grasslands and newly sown leys<sup>1</sup>. Post-emergent applications (spray between mid-October and end of February) should be carried out only after the grass has at least 2-3 leaves and is growing well<sup>2</sup>. Pre-emergent applications (spray crops drilled between mid-August and end of September) should be carried out within 2 days of drilling and before crop or weed emergence<sup>2</sup>. Soil moisture is required for good weed control and dry soils should not be treated (nor should waterlogged soils)<sup>2</sup>. Application can be by tractor-mounted sprayer.

### Fate in soil

Ethofumesate is moderately persistent in soil (DT<sub>50lab</sub> values of 10-122 days and DT<sub>50field</sub> values of 84-407 days)<sup>3</sup> but susceptible to degradation in soil through the action of sunlight<sup>3</sup>. Ethofumesate is moderately soluble (25 mg l<sup>-1</sup>)<sup>3</sup> and is weakly/moderately bound to soil (mean K<sub>oc</sub> value of 203)<sup>3</sup>. Therefore, there is a risk of leaching which has been investigated in the field and found to be of low risk. However, movement to surface water via run-off and drainage (especially immediately following application) is a possibility.

## Ethofumesate

(eg *Barclay Keeper 500 FL*, suspension concentrate)

### Fate in water

Ethofumesate is resistant to hydrolysis but is susceptible to degradation in water through the action of sunlight<sup>3</sup>. It has a moderate logK<sub>ow</sub> of 2.7 and as such has a low potential to bioaccumulate.

### Effects on terrestrial fauna

Generally, ethofumesate is regarded as being of low mammalian toxicity<sup>3</sup>. It has an acute oral LD<sub>50</sub> in the rat of >5,000 mg kg<sup>-1</sup><sup>3</sup> and an inhalation LC<sub>50 4hours</sub> of >3.97 mg l<sup>-1</sup> in the rat<sup>3</sup>. It is not an eye and skin irritant<sup>3</sup>. The risk to birds is low (LD<sub>50</sub> for ducks >3,552 mg kg<sup>-1</sup>)<sup>3</sup> and ethofumesate is non-toxic to bees (LC<sub>50</sub> >50 µg per bee)<sup>3</sup>. Ethofumesate is not toxic to earthworms (LC<sub>50</sub> 134 mg kg<sup>-1</sup>)<sup>3</sup>.

### Effects on aquatic fauna

Ethofumesate has been found to be of moderate toxicity to fish (LC<sub>50 96h</sub> trout 11.9 mg l<sup>-1</sup>)<sup>3</sup>, water fleas (EC<sub>50 48hours</sub> 13.5 mg l<sup>-1</sup>)<sup>3</sup> and algae (EC<sub>50</sub> 3.9 mg l<sup>-1</sup>)<sup>3</sup>. Given ethofumesate's moderate soil persistence and mobility in soil, care should be exercised when applying near to watercourses.

### Effects on non-target plants

Application of ethofumesate will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants, although data on aquatic species' sensitivities are not available.

### Efficacy/safety<sup>2,4</sup>

See table overleaf.



**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Annual meadow-grass, black-grass, canary-grass, ripgut brome, rough meadow-grass, stink-grass, volunteer cereals, wall barley, wild oat, yellow bristle-grass, Yorkshire fog.

**Daisy family (Asteraceae):** Cudweed, prickly lettuce, smooth sow-thistle.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Annual morning glory, cleavers, common chickweed, common purslane, fat-hen, fiddleneck, Japanese-lantern, knotgrass, leafy-fruited nightshade, nettle-leaved goosefoot.

#### Moderately susceptible:

**Grasses:** Barren brome, cockspur, finger-grasses, Johnson-grass, soft brome, wild oat, volunteer oat.

**Other monocotyledons:** Galingales.

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, groundsel, pineappleweed.

**Other dicotyledons:** Amaranths, black nightshade, common nettle, common stork's-bill, henbit dead-nettle, mallows, pigweed, Russian thistle, stork's-bills, summer-cypress.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Bermuda-grass, Italian rye-grass, rescue brome, yard-grass. Other perennial grasses.

**Daisy family (Asteraceae):** Dandelion, sunflower.

**Cabbage family (Brassicaceae):** Cabbage/rape, dittander, garden radish, London-rocket, shepherd's purse, swine-cresses.

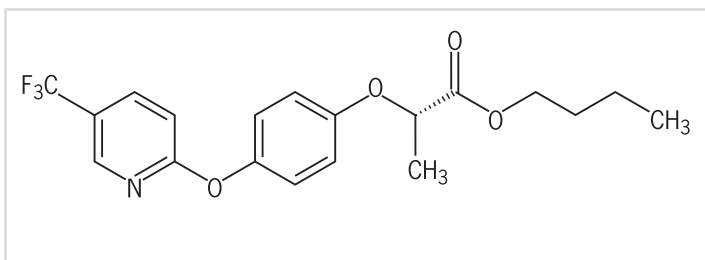
**Other dicotyledons:** Field bindweed, thorn-apples, dock, dodder, knotweeds, ribwort plantain, procumbent yellow-sorrel.

#### Livestock withholding period

Normally – at least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Barclay Chemicals Ltd, *Keeper 500 FL* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Weed susceptibility chart, University of California, Co-operative Extension program, Ed. D Cudney (2000).



## Fluazifop-p-butyl

(Fusilade 250 EW; emulsion, oil in water)

### Summary

Fluazifop-p-butyl is a selective, post-emergent, phenoxy-acid (single enantiomer) herbicide; available only as a single active product. Once absorbed by the leaves it is hydrolysed to the acid which is translocated in the xylem and phloem. It degrades rapidly in most matrices to give the acid, which is more persistent than the parent. It has low toxicity to mammals and most other wildlife, but may adversely impact on aquatic flora and fauna. Therefore, extra care should be exercised when applying close to natural water-bodies.

### Application scenarios

Fluazifop-p-butyl is used for the control of perennial grasses in farm forestry, set-aside, areas temporarily removed from cropping and field margins<sup>1,2</sup>. Application should be before weeds become competitive<sup>2</sup>. Speed of kill is more rapid when weeds are growing actively under warm conditions and with adequate soil moisture. In farm forestry situations, it should only be used in plantations established on land that was previously under arable cultivation or improved grassland. Application is as a foliar spray using tractor-mounted equipment. **Knapsack and hand-held sprayers should NOT be used.**

### Fate in soil

Fluazifop-p-butyl is known to degrade very rapidly in soil with DT<sub>50</sub> values of less than one day<sup>3</sup>, to give the acid which itself degrades with DT<sub>50</sub> values of between 2 and 12 weeks<sup>4</sup>. Fluazifop-p-butyl is sparingly soluble in water (1.1 mg l<sup>-1</sup>)<sup>3</sup> and is relatively strongly bound to soil (K<sub>oc</sub> value of 5,800)<sup>3</sup>. However, the acid metabolite is much more likely to leach into groundwater.

### Fate in water

Fluazifop-p-butyl is degraded in natural water systems very rapidly (apparent DT<sub>50</sub> of less than one day) and/or rapidly adsorbed by sediment, where it degrades to its acid. The acid degrades in the water phase with moderate persistence<sup>4</sup>. Fluazifop-p-butyl itself has a logK<sub>ow</sub> of 4.53 indicating a potential to bioaccumulate, but is degraded too rapidly to do so. The acid metabolite would not be expected to bioaccumulate.

### Effects on terrestrial fauna

Generally, fluazifop-p-butyl is regarded as relatively non-toxic to mammals<sup>3</sup> with an oral LD<sub>50</sub> in the rat of 2,712 mg kg<sup>-1</sup> and dermal LD<sub>50</sub> in the rat of >6,050 mg kg<sup>-1</sup>.

It causes slight skin irritation, and is mildly irritating to the eye<sup>4</sup>. Fluazifop-p-butyl is also non-toxic to birds (oral LD<sub>50</sub> for ducks >3,500 mg kg<sup>-1</sup>)<sup>3</sup> and bees (oral LD<sub>50</sub> 120 mg per bee)<sup>4</sup>. Fluazifop-p-butyl is not harmful to worms (LC<sub>50</sub> >1,000 mg kg<sup>-1</sup>)<sup>3</sup>. It also poses a low risk to a range of other arthropod species and groups, including ground beetles and lycosid spiders.

The very low toxicity of fluazifop-P-butyl to birds means that it poses a negligible risk to geese and other birds feeding on recently treated crops or weeds. Similarly, there is a negligible risk of adverse effects on birds nesting in or around treated fields or feeding on earthworms or insects in treated areas. Due to the very low risk to honey bees, there is no requirement to avoid fluazifop-P-butyl applications when bees may be foraging on flowering weeds.

### Effects on aquatic fauna

Fluazifop-p-butyl has been found to be of moderate to high toxicity to aquatic fauna<sup>3</sup> with fish LC<sub>50</sub> values of around 1 mg l<sup>-1</sup>, and water fleas EC<sub>50</sub> 48hours of >1 mg l<sup>-1</sup>. Algae are also relatively sensitive with EC<sub>50</sub> values of 0.51 mg l<sup>-1</sup> quoted<sup>3</sup>.

### Effects on non-target plants

Application of fluazifop-p-butyl will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants, although data on aquatic species' sensitivities are not available.

Trees are generally not very sensitive, but damage can occur if applications are made during bud burst/flushing.

### Efficacy/safety<sup>2,5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Barley, barren brome, black bent, blackgrass, canary-grass, common couch, creeping bent, drooping brome, finger-grasses, Italian rye-grass, Johnson-grass, perennial rye-grass, ripgut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

#### Moderately susceptible:

**Grasses:** Bermuda-grass.

**Dicotyledons:** Stork's-bills.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow grass, beetle-grass sp., chewing's fescue, cockspar, crested dog's-tail, fine-leaved sheep's fescue, hard fescue, red fescue, sheep's fescue.

**Other monocotyledons:** Galingales.

**Conifers:** Blue spruce, cypress, Douglas fir, European silver-fir, Japanese larch, noble fir, Norway spruce, pine, Sitka spruce, western red cedar.

**Other trees and shrubs:** Alder, ash, beech, elm, common oak, maple, sycamore, willow.

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, cudweed, dandelion, groundsel, pineappleweed, prickly lettuce, smooth sow-thistle, sunflower, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, dittander, garden radish London-rocket, shepherd's purse, swine-cress.

**Pea family (Fabaceae):** Medicks, melilots.

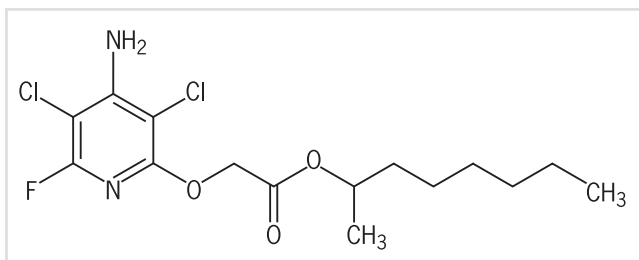
**Other dicotyledons:** Amaranths, annual morning glory, black nightshade, common chickweed, common nettle, common purslane, curled dock, dodder, fat-hen, fiddleneck, field bindweed, henbit dead-nettle, Japanese-lantern, knotgrass, knotweeds, leafy-fruited nightshade, mallows, nettle-leaved goosefoot, procumbent yellow-sorrel, ribwort plantain, summer-cypress, thorn-apples, velvetleaf.

#### Livestock withholding period

Normally – keep livestock out for at least 24 hours and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Syngenta UK Ltd, *Fusilade* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Evaluation on Fluazifop-p-butyl; UK-PSD, 1988.
- (5) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



## Fluroxypyr (meptyl)

(eg *Barclay Hurler*, emulsifiable concentrate)

### Summary

Fluroxypyr, available as its meptyl-derivative (1-methylheptyl), is a selective, post-emergent, pyridine herbicide; available as a single active product. It is absorbed by foliage and once in the plant the meptyl ester is cleaved to give the active acid parent, which is translocated to other parts of the plant. The parent acid is weakly bound to soil, however, despite moderate degradation rates in soil field studies indicate a low risk of leaching, but movement to surface water is a possibility. Fluroxypyr is of low mammalian toxicity and not expected to adversely impact soil fauna. However, the parent acid is slightly toxic to aquatic organisms (and moderately toxic to aquatic plants). therefore, every effort should be made to avoid contamination of watercourses.

### Application scenarios

Fluroxypyr is registered for the post-emergent control of certain broad-leaved weeds in established grasslands and newly sown leys<sup>1</sup>. Applications in established grassland is normally in the spring, up to mid-June<sup>2</sup>. Applications in newly established leys is in early autumn when the grasses are firmly established. Weeds should be small and actively growing<sup>2</sup>. Application can be by tractor-mounted sprayer or knapsack sprayer<sup>2</sup>.

### Fate in soil

Fluroxypyr acid is moderately persistent in soil under laboratory conditions (DT<sub>50lab</sub> values of 3-55 days) with the meptyl-ester possibly more persistent<sup>3</sup>. The meptyl-ester is much more rapidly degraded in the field (parent acid DT<sub>50field</sub> values of 34-68 days and meptyl-ester degraded to the acid with DT<sub>50field</sub> <3 days)<sup>3</sup>. Fluroxypyr is not susceptible to degradation in soil through the action of sunlight<sup>3</sup>. The meptyl-ester has low water solubility (<0.2 mg l<sup>-1</sup>)<sup>3</sup> whereas the parent acid is very water soluble (5.7 g l<sup>-1</sup> at pH5). The meptyl-ester is immobile in soil (K<sub>oc</sub> values 6,200-43,000) whereas the parent acid is weakly bound to soil (K<sub>oc</sub> value of 51-81)<sup>3</sup>. Therefore, there is a risk of the acid leaching, which has been investigated in the field and found to be low. However, movement to surface water via run-off and drainage (especially immediately following application) is a possibility.

### Fate in water

Fluroxypyr-ester hydrolyses to the parent acid with a DT<sub>50</sub> of 17.5 days (at pH7)<sup>3</sup>, the acid is hydrolytically stable but is microbially degraded in the water phase with a DT<sub>50</sub>

value of 24 days. The meptyl-ester is rapidly absorbed to sediment and rapidly degraded to the acid. The meptyl-ester has a high logP value (4.5) but its rapid degradation implies a low bioaccumulation risk<sup>3</sup>. The parent acid also has a low bioaccumulation risk as its logK<sub>ow</sub> is low (2.0)<sup>3</sup>.

### Effects on terrestrial fauna

The meptyl-ester is regarded as being of low mammalian toxicity<sup>3</sup>. In the rat, it has an acute oral LD<sub>50</sub> of >2000 mg kg and an inhalation LC<sub>50</sub> of >1.00 mg l<sup>-1</sup>. It is not an eye and skin irritant<sup>3</sup>. The risk to birds from both acid and meptyl-ester is low (LD<sub>50</sub> >2,000 mg kg<sup>-1</sup>)<sup>3</sup>, and meptyl-ester is non-toxic to bees (LC<sub>50</sub> >100 µg per bee)<sup>3</sup>. Meptyl-ester is not toxic to earthworms (LC<sub>50</sub> >1,000 mg kg<sup>-1</sup>)<sup>3</sup> and both acid and meptyl-ester are not toxic to a range of beneficial insects<sup>3</sup> and soil microbes<sup>3</sup>.

### Effects on aquatic fauna

Fluroxypyr acid has been found to be of low toxicity to fish (LC<sub>50</sub> 96h trout >100 mg l<sup>-1</sup>)<sup>4</sup> and water fleas (EC<sub>50</sub> 48hours >100 mg l<sup>-1</sup>)<sup>3</sup> and slightly toxic to algae (*Selenestrum capricornutum* LC<sub>50</sub> 49.8 mg l<sup>-1</sup>)<sup>3</sup>. The formulated product has a higher toxicity to aquatic organisms (*O. mykiss* LC<sub>50</sub> 3.5 mg l<sup>-1</sup>, water fleas EC<sub>50</sub> 0.8 mg l<sup>-1</sup>, *S. subspicatus* LC<sub>50</sub> 1.8 mg l<sup>-1</sup>)<sup>3</sup>. Given fluroxypyr acid's moderate soil persistence and mobility in soil, care should be exercised when applying near to watercourses.

### Effects on non-target plants

Application of fluroxypyr will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants (fat duckweed LC<sub>50</sub> of 12.3 mg l<sup>-1</sup> for parent acid)<sup>3</sup>.

### Efficacy/safety<sup>2,5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Dandelion, groundsel, mayweed.

**Other dicotyledons:** Black-bindweed, black nightshade, broad-leaved dock, cleavers, common chickweed, common fumitory, common nettle, corn spurrey, curled dock, field forget-me-not, knotgrass, pale persicaria, red dead-nettle, speedwell,

#### Resistant:

**Cabbage family (Brassicaeae):** Charlock, common orache, field penny-cress, shepherd's purse.

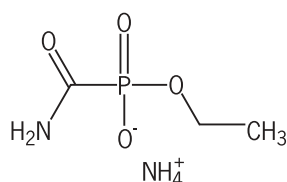
**Other dicotyledons:** Bugloss, common poppy, corn marigold, fat-hen, scarlet pimpernel, small nettle.

#### Livestock withholding period

Normally – at least 3 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
[www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm).
- (2) Barclay Chemicals Ltd, *Hurler* product label.
- (3) EU review report for the active substance Fluroxypyr, 6848/VI/98-rev.13 (1999).
- (4) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (5) Dow AgroSciences, Starane 2 product label.



## Fosamine-ammonium

(Krenite; soluble concentrate)

**NB:** This herbicide is withdrawn from sale on 24 July 2003 and last day of use is 31 December 2003, as a result of the EC review of approved pesticides. The manufacturer has not supported its continued use.

### Summary

Fosamine is a selective, post-emergent, organophosphorus herbicide; available only as a single active product. It is a contact herbicide with slight systemic activity absorbed by foliage, stems and buds. Despite being extremely water-soluble, leaching of fosamine into groundwater is not expected, as it degrades rapidly in soil. It has a low mammalian toxicity and low toxicity to wildlife, and is not expected to adversely impact soil and aquatic fauna.

### Application scenarios

Fosamine is used for the control of woody plants, including deciduous trees and shrubs and for bracken control in non-crop areas, waterside areas and conifer plantations<sup>2</sup>. Susceptible treated plants normally fail to re-foliate during the growing season following treatment and subsequently die. Application is as a foliar spray using knapsack, or equivalent, sprayers.

### Fate in soil

Fosamine is known to degrade very rapidly in soil via microbial processes. Soil DT<sub>50</sub> values are relatively short (7-10 days<sup>4</sup>). Fosamine is extremely water soluble (1,790 g l<sup>-1</sup>)<sup>5</sup> and is not adsorbed tightly to soil (K<sub>oc</sub> value of 8)<sup>3</sup>. Despite the relatively high mobility of fosamine, its rapid degradation in soil means that it is highly unlikely to leach into groundwater. Movement into surface water via run-off, though, is a possibility.

### Fate in water

Fosamine is apparently degraded in natural water systems via microbially mediated processes but is not susceptible to abiotic degradation<sup>3</sup>. It has a low potential to bioaccumulate (logK<sub>ow</sub> value of -2.92)<sup>3</sup> in fish or other aquatic species.

### Effects on terrestrial fauna

Generally, fosamine is regarded as completely non-toxic with an oral LD<sub>50</sub> in the rat of 24,400 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >1,682 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >42 mg l<sup>-1</sup><sup>3</sup>. It does not cause skin irritation and is not irritating to the eye<sup>3</sup>. Fosamine is non-toxic to birds (oral LD<sub>50</sub> for all birds tested >10,000 mg kg<sup>-1</sup>)<sup>4</sup> and bees (oral LD<sub>50</sub> >200 mg per bee)<sup>3</sup>. Fosamine is not harmful to small mammals<sup>3</sup>.

### Effects on aquatic fauna

Fosamine has been found to be non-toxic to fish (LC<sub>50</sub> around 380 mg l<sup>-1</sup>)<sup>3</sup> and water fleas (LC<sub>50</sub> 48hours 1,524 mg l<sup>-1</sup>)<sup>4</sup>. Algae are the most sensitive species but toxicity is low to moderate (*Selenastrum capricornutum* EC<sub>50</sub> >18 mg l<sup>-1</sup>)<sup>3</sup>.

### Effects on non-target plants

Application of fosamine will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants, although aquatic species are not regarded as being especially sensitive (NOEC for fat duckweed is given as <21 mg l<sup>-1</sup>)<sup>3</sup>.

Most deciduous trees and shrubs are controlled but evergreen species are generally unaffected. One advantage of fosamine-ammonium is that it has little effect on the herbaceous vegetation beneath treated plants.

### Efficacy<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Trees & shrubs:** Alders, alder buckthorn, ash, beech, blackthorn, briar, buckthorn, elder, elms, hawthorn, hazel, hornbeam, limes, bog myrtle, oaks, poplar, raspberry, roses, silver birch.

**Other dicotyledons:** Bird's-foot, bramble.

#### Moderately susceptible:

**Ferns:** Bracken.

**Trees & shrubs:** Dogwood, field maple, rowan, sycamore, willows.

**Other dicotyledons:** Old man's beard.

#### Resistant:

**Mosses:** *Sphagnum* spp.

**Grasses:** Common bent, false oat-grass, sheep's-fescue, smooth meadow-grass, Yorkshire-fog.

**Other monocotyledons:** Field wood-rush.

**Conifers:** Douglas fir, Monterey pine, Sequoia *Sequoiadendron sempervirens*, Sitka spruce.

**Other trees and shrubs:** Broom, gorse, greenweeds, rhododendron.

**Daisy family (Asteraceae):** Common ragwort, daisy, mouse-ear-hawkweed, smooth hawk's-beard, thistles.

**Other dicotyledons:** Buttercups, cleavers, common nettle, cow parsley, cowberry, foxglove, heaths, heath bedstraw, heather, honeysuckle, sheep's sorrel, willowherbs.

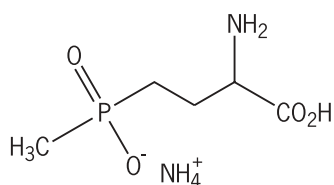
#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
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- (2) DuPont Ltd.. *Krenite* product label.
- (3) US-EPA RED document, EPA 738-R-95-004 (1995).  
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- (4) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (5) Fosamine ammonium (Krenite) Herbicide Profile 2/85.  
(<http://pmep.cce.cornell.edu/profiles/herb-growthreg>)
- (6) Cooke, A S. 1986. The use of herbicides on nature reserves. *Focus on nature conservation* No. 14. Nature Conservancy Council, Peterborough.





## Glufosinate-ammonium

(eg Challenge; soluble concentrate)

### Summary

Glufosinate-ammonium is a non-selective, post-emergent, contact organophosphorus herbicide; available only as a single active product. It degrades very rapidly in most matrices. In general, the formulated product is more toxic than the active ingredient. When applying, care should be exercised to minimise effects in non-target areas, due to spray drift.

### Application scenarios

Glufosinate-ammonium is used for the control of annual and perennial broad-leaved weeds and grasses in cultivated land/soil, sward destruction in grassland, land temporarily removed from production and non-crop farm areas<sup>1,2</sup>. Application should not take place if vegetation or soil are very wet or if rain is expected within 6 hours of application<sup>2</sup>. Weeds should be actively growing at the time of application, which can take place from March to September. Application is as a foliar spray using tractor-mounted equipment, or knapsack and other hand-held sprayers.

### Fate in soil

Glufosinate-ammonium is known to degrade very rapidly in soil with DT<sub>50</sub> values ranging from 3-10 days under laboratory conditions and 7-20 days in the field<sup>3</sup>. Glufosinate-ammonium is extremely soluble in water (1,370 g l<sup>-1</sup>)<sup>3</sup>. Strength of soil binding depends on the soil, with stronger binding to clay soils and those with higher organic carbon content (K<sub>oc</sub> values between 10 and 1,230)<sup>3</sup>. Although glufosinate-ammonium is regarded as mobile, its fast degradation, tight binding to clays and application timing reduces the likelihood of contamination of ground-water.

### Fate in water

Glufosinate-ammonium is not degraded by abiotic processes in water<sup>3</sup>. However, it is susceptible to biotic processes with microbial-mediated degradation leading to a DT<sub>50</sub> in natural water of 2-30 days<sup>3</sup>. Glufosinate-ammonium has a very low logK<sub>ow</sub> (-1)<sup>4</sup> - indicating a very low potential to bioaccumulate.

### Effects on terrestrial fauna

Generally, glufosinate-ammonium is regarded as moderately toxic with, for rats<sup>4</sup>, an oral LD<sub>50</sub> of 1,510 mg kg<sup>-1</sup>, a dermal LD<sub>50</sub> of >4,000 mg kg<sup>-1</sup> and an acute inhalation LC<sub>50</sub> of around 3 mg l<sup>-1</sup>. It causes slight skin irritation and is mildly irritating to the eye<sup>4</sup>. Glufosinate-ammonium is

non-toxic to birds (oral LC<sub>50</sub> for quail >5,000 mg kg<sup>-1</sup>)<sup>3</sup> and bees (oral LD<sub>50</sub> 104 mg per bee)<sup>4</sup>. Glufosinate-ammonium is not harmful to worms (LD<sub>50</sub> >1,000 mg kg<sup>-1</sup>)<sup>3</sup>.

### Effects on aquatic fauna

Glufosinate-ammonium has been found to be of low toxicity to aquatic fauna<sup>3</sup>, with fish LC<sub>50</sub> values of around 700 mg l<sup>-1</sup>, and water fleas LC<sub>50</sub> 48hours of around 560 mg l<sup>-1</sup>. However, the formulated product is significantly more toxic in the aquatic environment than the active ingredient alone, with fish and water fleas LC<sub>50</sub> values being much lower (12-20 mg l<sup>-1</sup>)<sup>2,4</sup>. Algae are also relatively sensitive with EC<sub>50</sub> values of 37 mg l<sup>-1</sup> for *Selenastrum capricornutum*<sup>3</sup>.

### Effects on non-target plants

Application of glufosinate-ammonium will pose a risk to all plants outside of the target area, where spray drift is possible. Care should, therefore, be taken to minimise such drift. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants. The bottom of hedges should not be treated<sup>2</sup>.

### Efficacy/safety<sup>5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Annual meadow-grass, beetle-grass sp., Bermuda-grass (seedlings), canary-grass, cocksbur, drooping brome, finger-grasses, ripgut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

**Other monocotyledons:** Galingales.

**Daisy family(Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, cudweed, dandelion (seedlings), groundsel, mustard, pineappleweed, prickly lettuce, smooth sow-thistle, sunflower, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/rape, garden radish, London-rocket, shepherd's purse.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Amaranths, annual morning glory, black nightshade, common chickweed, common nettle, common purslane, dock (seedlings), fat-hen, fiddleneck, field bindweed (seedlings), henbit dead-nettle, Japanese-lantern, knotweeds, leafy-fruited nightshade, mallows, nettle-leaved goosefoot, ribwort plantain (seedlings), stork's-bills, summer-cypress.

#### Moderately susceptible:

**Grasses:** Bermuda-grass, Johnson-grass.

**Dicotyledons:** Dodder, field bindweed, knotgrass.

#### Resistant:

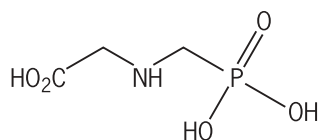
**Pteridophytes:** Horsetails.

#### Livestock withholding period

Normally – until foliage of poisonous weeds such as ragwort has died and become unpalatable.  
Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Aventis CropScience UK Ltd. *Challenge* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Evaluation on Glufosinate-ammonium; UK-PSD, 1990.
- (5) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



# Glyphosate

(eg Roundup, Roundup Biactive; soluble concentrates)

## Summary

Glyphosate is a non-selective, post-emergent, contact, organophosphorus herbicide, absorbed by the foliage with rapid translocation throughout the plant. It is available only as a single active product but from a large number of different sources. In products it is usually present as a salt and, in general, the formulated product is more toxic than the active ingredient. Glyphosate degrades very rapidly in most matrices. When applying, care should be exercised to minimise effects in non-target areas, due to spray drift. When used in aquatic situations, strict adherence to all statutory requirements is especially important, to avoid unacceptable adverse impacts.

## Application scenarios

Glyphosate is used for the control of annual and perennial broadleaved weeds and grasses, and a wide range of other unwanted plant material (eg bracken, rushes, woody weeds, brambles and water lilies) in amenity grass and vegetation, sward destruction in grassland, land temporarily removed from production and non-crop farm areas, aquatic situations, road verges and stubbles<sup>1,2</sup>. Application should not take place if the vegetation or soil is very wet, or if rain is expected within 6 hours of application (and preferably not within 24 hours of application<sup>3</sup>). Weeds should be actively growing at application, which can take place from June to October. Application is as a foliar spray using tractor-mounted equipment, with knapsack and other hand-held sprayers, or by weed-wipe.

## Fate in soil

Glyphosate is known to degrade rapidly in soil with DT<sub>50</sub> values ranging from 3-174 days in the field<sup>3</sup>. Glyphosate is very soluble in water (11.6 g l<sup>-1</sup>)<sup>3</sup> with glyphosate-salts even more soluble. Strength of soil binding depends on the soil, but is generally moderate to tight (K<sub>d</sub> values between 62 and 175)<sup>4</sup>. Although glyphosate is regarded as potentially mobile, its fast degradation, relatively tight binding to soils and application timing reduces the likelihood of contamination of groundwater.

## Fate in water

Glyphosate is rapidly degraded in natural water/sediment systems via biotic processes (DT<sub>50</sub> ≤14 days)<sup>3</sup>. Glyphosate has a very low logK<sub>ow</sub> (< -3.2)<sup>3</sup> - indicating a very low potential to bioaccumulate.

## Effects on terrestrial fauna

Generally, glyphosate is regarded as having moderate mammalian toxicity<sup>4</sup>, with an acute oral LD<sub>50</sub> in the rat of around 5,000 mg kg<sup>-1</sup><sup>3</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup><sup>4</sup> and acute inhalation LC<sub>50</sub> in the rat of around 3 mg l<sup>-1</sup><sup>5</sup>. It does not cause skin irritation but is mildly irritating to the eye<sup>3</sup>. Glyphosate is non-toxic to birds (oral LC<sub>50</sub> for quail 3,851 mg kg<sup>-1</sup>)<sup>3</sup> and is non-toxic to bees (oral LD<sub>50</sub> >100 mg per bee)<sup>6</sup>. Glyphosate is not harmful to worms (LD<sub>50</sub> >5,000 mg kg<sup>-1</sup>)<sup>3</sup>.

A study of the effects of glyphosate (and propyzamide) on non-target insects in farm forestry<sup>7</sup> found no significant effects on mortality of chafer larvae or adult ground beetles. This led the researchers to the conclusion that glyphosate is non-toxic, at least to the various herbivorous and predatory species tested. Laboratory studies<sup>8</sup> investigating the direct effects of glyphosate on non-target spiders *Lepthyphantes tenuis* found that spider mortality was less than 10% after 48 hours and still under 15% after 72 hours - suggesting that glyphosate was harmless to these arthropods. Indirect effects were also studied in field margins which had been sprayed with varying levels of glyphosate<sup>8</sup>. The abundance of spiders was significantly lower in the sprayed plots compared to an unsprayed control plot. The reasons for this decline seemed to be increased amounts of dead vegetation and decreasing height of the remaining vegetation. The glyphosate applications only had a within-season indirect effect on the spider

## Effects on aquatic fauna

Glyphosate has been found to be of low to moderate toxicity to aquatic fauna<sup>3</sup> with fish LC<sub>50</sub> values of 86 mg l<sup>-1</sup> and water fleas LC<sub>50</sub> 48hours of 780 mg l<sup>-1</sup>. However, the formulated product is more toxic in the aquatic environment than the active ingredient alone, with fish and water fleas LC<sub>50</sub> values being lower (4-16 mg l<sup>-1</sup>)<sup>5</sup>. Algae are also relatively sensitive with a EC<sub>50</sub> 7days value of 0.64 mg l<sup>-1</sup> for *Selenastrum costatum*<sup>3</sup>.

## Effects on non-target plants

Glyphosate is toxic to most plant species. Consequently, application of glyphosate will pose a risk to all plants outside of the target area, where spray drift is possible. Care should be taken to minimise such drift. Likewise, drift into watercourses close to the application area could also result in damage to non-target aquatic plants. Where

glyphosate is used for control of aquatic species, strict adherence to all statutory requirements is especially important, to avoid unacceptable adverse impacts.

#### **Efficacy/safety**<sup>2,9,10,11</sup>

Most plant species are damaged by glyphosate, so great care must be taken to avoid contact with non-target species. However, there are differences in the relative sensitivities of plants. The table below gives an indication of those species that are likely to be killed by relatively low rates and those which are killed only by high rates. Species listed as 'moderately resistant' are those showing resistance to glyphosate at rates of 3.0 kg a.i. ha<sup>-1</sup> or higher<sup>11</sup>.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### **Terrestrial species**

##### **Susceptible:**

**Ferns:** Bracken.

**Grasses:** African love-grass, annual meadow-grass, autumn millet, barley, barren brome, beetle-grass sp., bents, Bermuda-grass, black bent, blackgrass, bristle bent, bristle-grasses, canary-grass, cat's-tails, cock's-foot, cockspur, common couch, common reed, confused canary-grass, creeping bent, creeping soft-grass, crested-dog's tail, darnel, drooping brome, European bur-grass, false oat-grass, fescues, finger-grasses, foxtail brome, great brome, green bristle-grass, hairy finger-grass, Highland bent, Italian rye-grass, Johnson-grass, loose silky-bent, oats, meadow fescue, onion couch, perennial rye-grass, purple moor-grass, reed canary-grass, reed sweet grass, rescue brome, ripgut brome, rough meadow-grass, sandburs, slender oat, soft-brome, smooth meadow-grass, sharp-flowered signal-grass, stink-grass, sweet vernal grass, Timothy, volunteer cereals, wall barley, wild oat, winter wild-oat, wood millet, wood small-reed, yard-grass, yellow bristle-grass, yellow oat-grass, Yorkshire fog.

**Other monocotyledons:** Bulrush, sedges, white water lily, wood-rushes yellow water lily.

**Other trees & shrubs:** Alders, alder buckthorn, ash, aspen, beech, black wattle, blackthorn, dog rose, elder, goat willow, oaks, privet, raspberry, rowan, silver birch, sweet chestnut, hawthorns, sycamore, western gorse.

#### **Glyphosate. Cont...**

**Daisy family Asteraceae):** Argentine fleabane, black-jack, bristly ox-tongue, burdocks, butterbur, Canadian fleabane, chamomile sp., cocklebur, colts-foot, common fleabane, common ragwort, corn chamomile, corn marigold, creeping thistle, crown daisies, cudweed, dandelion, dwarf marigold, field marigold, flossflower, gallant soldier, golden thistle, groundsel, hawk's-beards, hemp agrimony, Jersey cudweed, mayweeds, milk thistle, Michaelmas daisies, mugwort, oxeye daisy, perennial sow-thistle, pineappleweed, plain treasureflower, prickly lettuce, prickly sow-thistle, rough star-thistle, scented mayweed, scentless mayweed, smooth sow-thistle, southern marigold, spear thistle, stinking chamomile, sunflower, tansy, yellow star-thistle, wood ragwort.

**Cabbage family (Brassicaceae):** Bitter-cresses, black mustard, cabbage/rape, charlock, creeping yellow-cress, garden radish, hairy bitter-cress, London-rocket, perennial rocket, rockets, shepherd's purse, swine-cresses, thale cress, wall-rocket spp., water cress, white mustard, white wall-rocket, wild radish.

**Pea family (Fabaceae):** Black medick, liquorices, vetches, white clover (seedlings), yellow restharrow.

**Carrot family (Apiaceae):** Cow parsley, shepherd's-needle, fennels, fool's parsley, hogweed.

**Other dicotyledons:** African pepperwort, amaranths, amphibious bistort, annual morning glory, annual mercury, Bermuda buttercup, bistort, bittersweet, black bindweed, black nightshade, bramble, broad-leaved dock, cleavers, common amaranth, common chickweed, common field-speedwell, common fumitory, common hemp-nettle, common mouse-ear, common nettle, common orache, common poppy, common purslane, common stork's-bill, common toadflax, corn buttercup, corn mint, corncockle, corn spurrey, cranesbills, creeping buttercup, creeping cinquefoil, curled dock (seedlings), cut-leaved cranesbill, dodder, dog's mercury, dwarf mallow, fat-hen, fiddleneck, field bindweed (seedlings), field forget-me-not, field gromwell, field pansy, foxglove, fumitories, germander speedwell, gold-of-pleasures spp., great willowherb, greater plantain, green amaranth, green field-speedwell, grey field-speedwell, ground-ivy, henbit dead-nettle, hound's-tongues, ivy-leaved speedwell, Japanese-lantern, knotweeds, leafy-fruited nightshade, least mallow, mints, mouse-ears, nettles, nettle-leaved goosefoot, pale persicaria, parsley-piert, perforate St John's-wort, petty spurge, procumbent yellow-sorrel, prostrate pigweed, red dead-nettle, redshank, ribwort plantain (seedlings), rosebay willowherb, scarlet pimpernel, sheep's sorrel, small nettle, soft stork's-bill, speedwells, spurges, summer-cypress, sun spurge, thorn-apples, vervain, wall speedwell, white dead-nettle, wild pansy, woundworts.

**Moderately susceptible:**

**Pteridophytes:** Horsetails.

**Grasses:** Common bent, giant reed, meadow foxtail, red fescue, sheep's-fescue, tufted hair-grass, water finger-grass, wavy hair-grass.

**Other monocotyledons:** Galingales, Italian lords-and-ladies, rosy garlic, tassel hyacinth, wild onion.

**Conifers:** Corsican pine, Douglas fir, lodgepole pine, Norway spruce, Sitka spruce, Scots pine.

**Other trees & shrubs:** Alder, blackthorn, broom, common gum cistus, dog rose, green alder, greenweeds, downy birch, field maple, French lavender, gorse, guelder-rose, hazel, hornbeam, Montpellier rock-rose, raspberry, Spanish gorse, tree heath, willows.

**Daisy family Asteraceae):** Canadian goldenrod, daisies, goldenrod, greater burdock, oxtongues, tansy, yarrow.

**Pea family (Fabaceae):** Common bird's-foot-trefoil, lucerne, medicks, melilots, tufted vetch, white clover.

**Carrot family (Apiaceae):** Ground-elder, hoary cress, wild carrot.

**Other dicotyledons:** Buck's-horn plantain, common hemp-nettle, common purslane, corn buttercup, cowbane, curled dock, field bindweed, garden pink-sorrel, ground-ivy, heather, hedge bindweed, Japanese knotweed, knotgrasses, mallows, perfoliate honeysuckle, ribwort plantain, rosebay willowherb, stork's-bills, velvetleaf, wood sorrel.

**Moderately resistant:**

**Ferns:** Hard fern, male fern.

**Other monocotyledons:** Field garlic.

**Trees & shrubs:** rhododendron, Spanish heath.

**Daisy family Asteraceae):** Chinese mugwort, weltd thistle.

**Pea family (Apiaceae):** Clovers.

**Other dicotyledons:** Birthwort, cinquefoils, comfrees, stonecrops, traveller's-joy.

**Aquatic species****Susceptible:**

**Grasses:** Common reed, floating sweet-grass, reed canary-grass, reed sweet-grass, whorl-grass.

**Other monocotyledons:** Arrowhead, beak-sedges, branched bur-reed, bulrush, duckweeds, greater pond-sedge, hard rush, sea club-rush, sedges, sharp-flowered rush, soft rush, water-plantain,

**Daisy family Asteraceae):** hemp-agrimonies, marsh thistle, marsh sow-thistle.

**Other dicotyledons:** Water-cress, water-violet, white water-lily, yellow water-lily.

**Moderately susceptible:**

**Algae:** Cladophora spp., Enteromorpha intestinalis, Rhizoclonium spp. Spirogyra spp. Vaucheria dichotoma.

**Grasses:** Common reed.

**Other monocotyledons:** Branched bur-reed, Canadian waterweed, common club-rush, curled pondweed, horned pondweed, ivy-leaved duckweed, lesser bulrush, lords-and ladies, rushes, sedges, soft rush, yellow iris.

**Dicotyledons:** Amphibious bistort, rigid hornwort, spiked water-milfoil, water hyacinth, water mint, whorled water-milfoil, water-pepper, woundworts.

**Moderately resistant:**

**Grasses:** Giant reed.

**Other monocotyledons:** Fennel pondweed.

**Dicotyledons:** Creeping yellow-cress.

**Resistant:**

**Monocotyledons:** Broad-leaved pondweed.

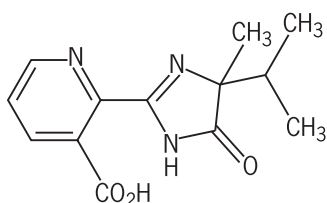
## Livestock withholding period

Normally – no grazing allowed at all. Check the label.

## Glyphosate. Cont...

### References

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- (9) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).
- (10) Aquatext. Herbicide susceptibility key. ([www.aquatext.com/tables/herbsusc.html](http://www.aquatext.com/tables/herbsusc.html)).
- (11) Cooke, A S. 1986. The use of herbicides on nature reserves. *Focus on nature conservation*, No.14. Nature Conservancy Council, Peterborough.
- (12) Willoughby, I., & Clay, D. 1996. *Herbicides for farm woodlands and short rotation coppice*. Forestry Commission Field Book 14. HMSO, London.



### Summary

Imazapyr is a non-selective, pre- and post-emergent, systemic, imidazolinone herbicide; available only as a single active product. It is absorbed by foliage and roots and rapidly translocated in the xylem and phloem. Imazapyr is of low toxicity to aquatic and terrestrial organisms and is not expected to adversely impact the environment. However, there are indications that herbicidal activity may persist in soil for a considerable time after application, and use on slopes is discouraged.

### Application scenarios

Imazapyr is used for the control of annual and perennial broadleaved weeds, grasses and sedges, and scrub and deciduous tree species, in non-crop areas, farm buildings/ yards, fence-lines, forestry and railway tracks<sup>1,2</sup>. The product can be used as a site preparation treatment in forestry situations prior to planting of certain conifer species (eg Corsican pine, Japanese larch)<sup>2</sup>. Application should be when the weeds are actively growing. For forestry site preparation this would be between July and October and for bracken control during July and August<sup>2</sup>. Application can be by tractor-mounted sprayer or by knapsack sprayer.

### Fate in soil

Imazapyr degrades moderately slowly in soil with quoted residual activity in soil ranging from six months to two years<sup>3</sup>. Although not expected to accumulate, activity is regarded as 'residual'<sup>2</sup>.

Although imazapyr is very water-soluble (9.74 g l<sup>-1</sup>)<sup>3</sup>, leaching potential is regarded as moderate with K<sub>d</sub> values between 1.7 and 4.94. However, movement by run-off processes is suspected<sup>2</sup>.

### Fate in water

Imazapyr is regarded as being susceptible to degradation by the action of sunlight in natural water systems and may bind moderately tightly to sediment and suspended particles. However, with a low LogK<sub>OW</sub> value (0.11)<sup>3</sup>, bioaccumulation is not expected.

### Effects on terrestrial fauna

Generally, imazapyr is regarded as of moderate mammalian toxicity with an acute oral LD<sub>50</sub> for rats of >5,000 mg kg<sup>-1</sup><sup>3</sup>, dermal LD<sub>50</sub> for rabbits of >2,000 mg kg<sup>-1</sup><sup>4</sup> and acute inhalation LC<sub>50</sub> in rats of >1.3 mg l<sup>-1</sup><sup>3</sup>. It is a

## Imazapyr

(eg Arsenal 50; soluble concentrate)

**NB:** This herbicide is withdrawn from sale on 24 July 2003 and last day of use is 31 December 2003, as a result of the EC review of approved pesticides. The manufacturer has not supported its continued use.

mild skin irritant and irritating to the eye<sup>3</sup>. It is non-toxic to birds (oral LC<sub>50</sub> for ducks >2,150 mg kg<sup>-1</sup>)<sup>3</sup> and non-toxic to bees (oral LD<sub>50</sub> >100 mg per bee)<sup>3</sup>.

### Effects on aquatic fauna

Imazapyr is regarded as of low toxicity to aquatic fauna<sup>3</sup> with fish LC<sub>50</sub> values of >100 mg l<sup>-1</sup> and water fleas LC<sub>50</sub> 48hours >100 mg l<sup>-1</sup>. No data are available on toxicity to algae.

### Effects on non-target plants

Application of imazapyr will pose a risk to all plants outside of the target area, where spray drift is possible. Care should be taken to minimise such drift. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants.

When used as a pre-plant treatment where conifers are to be grown, the conifer plants should be at least two years old. Imazapyr should not be used on other areas where desirable plants will be grown.

### Efficacy/safety<sup>2,5</sup>

See table overleaf.



**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Ferns:** Bracken.

**Grasses:** Annual meadow-grass, autumn millet, canary-grass, cock's foot, cockspur, common bent, couch grass, creeping soft grass, drooping brome, false oat grass, finger-grasses, Italian rye-grass, Johnson-grass (seedlings), perennial rye-grass, purple moor-grass, sandburs, smooth meadow-grass, stink-grass, tufted hair grass, wavy hair grass, wild-oat, wood small-reed, yard-grass, yellow bristle-grass, Yorkshire fog.

**Other monocotyledons:** Soft rush.

**Trees & shrubs:** rhododendron.

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, cudweed, dandelion, golden rod, groundsel, mugwort, prickly lettuce, ragwort, sunflower, yarrow, yellow star-thistle.

**Cabbage family (Brassicaceae):** London-rocket, shepherd's purse.

**Pea family (Fabaceae):** Common vetch, medicks, melilots, white clover.

**Other dicotyledons:** Amaranths, annual morning glory, black bindweed, broad-leaved dock, common chickweed, common nettle, common purslane, cranesbill, creeping buttercup, creeping cinquefoil, curled dock, fat-hen, fiddleneck, field bindweed, field pansy, hogweed, great plantain, henbit dead-nettle, knotgrass, knotweeds, nettle-leaved goosefoot, procumbent yellow-sorrel, ribwort plantain, rosebay willowherb, small nettle, St John's-wort, stork's-bills, summer-cypress, velvetleaf.

#### Moderately susceptible:

**Grasses:** Beetle-grass sp., Bermuda-grass.

**Daisy family (Asteraceae):** Creeping thistle, smooth sow-thistle.

**Other dicotyledons:** Mallows.

#### Resistant:

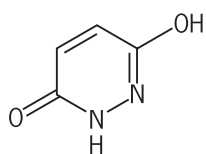
No known resistance in UK species.

#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Nomix-Chipman Ltd, *Arsenal 50* product data sheet.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Imazapyr (Arsenal) Herbicide Profile 9/85.  
(<http://pmep.cce.cornell.edu/profiles/herb-growthreg>).
- (5) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



## Maleic hydrazide

(eg *Mazide 25*; soluble concentrate)

### Summary

Maleic hydrazide is a plant growth inhibitor, uracil anti-metabolite, with limited herbicidal activity. It is absorbed by leaves and roots and translocated in the xylem and phloem. Maleic hydrazide is available as a single active product and as a mixture with other actives. It degrades very rapidly in soil and so, despite being very mobile, is not expected to constitute a risk to groundwater. It is not expected to have an adverse impact on terrestrial or aquatic environments.

### Application scenarios

Maleic hydrazide is used to retard grass and hedge growth, and to inhibit sucker and shoot re-growth on established trees, in amenity grass areas, road verges, hedges and grass near water<sup>1,2</sup>. **It should not be used on grass intended for grazing.** Grass is best treated in the spring shortly after it has begun to grow (usually in April/May). Hedges are also best treated in April or May, whereas trees are treated between March and May<sup>2</sup>. Application is as a foliar spray using tractor mounted spraying equipment or knapsack sprayers.

### Fate in soil

Maleic hydrazide degrades rapidly in soil with DT<sub>50</sub> values <1 day in the laboratory, under aerobic conditions<sup>3</sup>. Degradation under anaerobic conditions is somewhat slower (DT<sub>50</sub> values of 30-60 days)<sup>4</sup>. Maleic hydrazide is very soluble in water (around 4 g l<sup>-1</sup>)<sup>3</sup> and binding to soil is also weak with K<sub>d</sub> values of 0.14 to 2.61<sup>4</sup>. Although maleic hydrazide is regarded as potentially mobile, its fast degradation and application timing reduces the likelihood of contamination of groundwater.

### Fate in water

Maleic hydrazide is reported as being rapidly degraded in water via the action of sunlight<sup>3</sup>. It has a very low LogK<sub>ow</sub> (-1.96)<sup>3</sup> indicating a very low bioaccumulation potential. Water immediately adjacent to areas of treated grass should not be used for irrigation purposes for at least three weeks.

### Effects on terrestrial fauna

Generally, maleic hydrazide is regarded as moderately toxic to mammals<sup>3</sup> with an acute oral LD<sub>50</sub> in the rat of >5,000 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >20,000 mg kg<sup>-1</sup> and acute inhalation LC<sub>50</sub> in the rat of >3.2 mg l<sup>-1</sup>. It can give rise to mild skin irritation and slight eye

irritation<sup>3</sup>. Maleic hydrazide is non-toxic to birds (oral LD<sub>50</sub> for ducks >4,640 mg kg<sup>-1</sup>)<sup>3</sup> and is non-toxic to bees (oral LD<sub>50</sub> 36.25 mg per bee)<sup>4</sup>. Maleic hydrazide is not harmful to worms (LC<sub>50</sub> >1,000 mg kg<sup>-1</sup> for potassium salt)<sup>3</sup>.

### Effects on aquatic fauna

Maleic hydrazide has low toxicity to fish (LC<sub>50</sub> values are >1,435 mg l<sup>-1</sup>)<sup>3</sup> and low toxicity to water fleas (LC<sub>50</sub> 48 hours values are ≥108 mg l<sup>-1</sup>)<sup>3</sup>. Maleic hydrazide has low toxicity to algae (IC<sub>50</sub> 96 hours for *Chlorella* >100 mg l<sup>-1</sup>)<sup>3</sup>.

### Effects on non-target plants

No significant risks to non-target plants have been reported. Due to maleic hydrazide's mode of action (growth inhibition) it is unlikely that any effects would be long lasting.

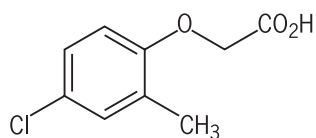
### Livestock withholding period

Normally – no grazing allowed at all. Check the label.

### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Vitax Ltd. *Mazide 25* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) US-EPA RED, EPA 738-R-93-010 (1994).  
([www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm)).





## MCPA

(eg *Agroxone*; soluble concentrate)

### Summary

MCPA is a selective, post-emergent, systemic, phenoxyacetic acid herbicide; available as a single active product or in mixtures. It is absorbed by the leaves and roots and translocated. In products it can be present as the acid, as a salt, ester or amine. The solubility of the active in the product can vary significantly, depending on the form of MCPA present. MCPA degrades rapidly in most matrices and apart from effects on non-target plants is not expected to adversely impact terrestrial or aquatic environments.

### Application scenarios

MCPA is approved for the control of annual and perennial broadleaved weeds in established grassland, forestry, road verges and amenity grass<sup>1,2</sup>. Weeds should be actively growing at application, which should optimally take place when annual weeds are at the seedling stage and when the flower buds are forming in perennial weeds<sup>2</sup>. Application is as a foliar spray, using tractor-mounted spraying equipment or knapsack and other hand-held sprayers, as appropriate.

### Fate in soil

MCPA degrades rapidly in soil, with a DT<sub>50</sub> that varies according to organic carbon content. For soils with less than 10% organic matter the DT<sub>50</sub> is very short (typically <1 day<sup>4</sup>) and where the organic matter content is >10%, DT<sub>50</sub> values are also short, typically <10 days<sup>4</sup>. MCPA and its salts are soluble in water (0.274 g l<sup>-1</sup> for the acid and 270 g l<sup>-1</sup> for the sodium salt)<sup>3</sup> but although MCPA is regarded as potentially mobile, its fast degradation and application timing reduces the likelihood of contamination of groundwater.

### Fate in water

MCPA does not degrade rapidly by chemical processes in aqueous environments<sup>4</sup>. It has a low LogK<sub>ow</sub> (-0.71 at pH7)<sup>3</sup>, indicating a very low bioaccumulation potential.

### Effects on terrestrial fauna

Generally, MCPA is regarded as moderately toxic to mammals. In rats, it has an acute oral LD<sub>50</sub> of 700<sup>1</sup>, 164 mg kg<sup>-1</sup><sup>3</sup>, dermal LD<sub>50</sub> of 4,800 mg kg<sup>-1</sup><sup>4</sup> and acute inhalation LC<sub>50</sub> of >6.36 mg l<sup>-1</sup><sup>3</sup>. It is classified as a severe eye irritant<sup>4</sup> and a skin irritant<sup>3</sup>. MCPA is moderately toxic to birds (oral LD<sub>50</sub> for quail 377 mg kg<sup>-1</sup>)<sup>3</sup> and non-toxic to bees (oral LD<sub>50</sub> 104 mg per bee)<sup>3</sup>. MCPA

is not harmful to worms (LD<sub>50</sub> 14days 325 mg kg<sup>-1</sup>)<sup>3</sup>. MCPA-derivatives appear to have similar toxicities to the acid.

### Effects on aquatic fauna

MCPA has been found to be of low toxicity to aquatic fauna, with LC<sub>50</sub> values of 232 mg l<sup>-1</sup> for fish and >100 mg l<sup>-1</sup> for water fleas<sup>3</sup>. MCPA is also of low toxicity to algae (EC<sub>50</sub> for *Selenastrum capricornutum* >392 mg l<sup>-1</sup>)<sup>3</sup>.

### Effects on non-target plants

Application of MCPA will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to minimise such drift. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants.

### Efficacy/safety<sup>2,5,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, dandelion (seedlings), prickly lettuce, smooth sow-thistle, sunflower.

**Cabbage family (Brassicaceae):** Black mustard, cabbage/rape, charlock, field penny-cress, garden radish, London-rocket, runch, shepherd's purse, white mustard.

**Other dicotyledons:** Amaranths, black nightshade, corn buttercup, creeping buttercup, curled dock (seedlings), fat-hen, greater plantain, hoary plantain, Japanese-lantern, leafy-fruited nightshade, nettle-leaved goosefoot, pigweed, ribwort plantain.

#### Moderately susceptible:

**Monocotyledons:** Common rush, soft rush.

**Daisy family (Asteraceae):** Annual sow-thistle, autumn hawkbit, cats-ear, common knapweed, common ragwort, creeping thistle, cudweed, daisy, dandelion, pineapple-weed, smooth hawks-beard, smooth sow-thistle, spear thistle, yellow star-thistle.

**Cabbage family (Brassicaceae):** Hoary cress.

**Other dicotyledons:** Annual morning glory, black nightshade, common chickweed, common fumitory, common hemp-nettle, common mouse-ear, common nettle, common orache, common poppy, common purslane, curled dock, fiddleneck, field gromwell, forget-me-nots, knotweeds, mallows, procumbent yellow-sorrel, ribwort plantain, scarlet pimpernel, self-heal, small nettle, stork's-bills.

#### Moderately resistant:

**Pteridophytes:** Horsetails.

**Daisy family (Asteraceae):** Corn chamomile, field pansy, perennial sow thistle, ragwort, scentless mayweed, yarrow.

**Other dicotyledons:** Corn spurrey, dove's-foot cranesbill, knotgrasses, pale persicaria, procumbent pearlwort, redshank, silverweed, sorrel, speedwells.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow-grass, autumn millet, barley, beetle-grass sp., Bermuda-grass, canary-grass, drooping brome, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, ripgut brome, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass.

**Other monocotyledons:** Galingales.

**Daisy family (Asteraceae):** Corn marigold, groundsel, mayweeds.

**Cabbage family (Brassicaceae):** Dittander, swine-creeses.

**Pea family (Fabaceae):** Medicks, melilots.

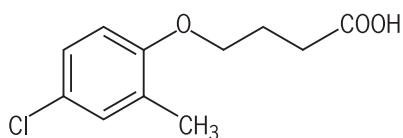
**Other dicotyledons:** Black bindweed, broad-leaved dock, cleavers, corn spurrey, dead-nettle, dodder, henbit dead-nettle, ivy-leaved speedwell, parsley-piert, red dead-nettle.

#### Livestock withholding period

Normally – until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Headland Agrochemicals UK Ltd. Agroxone product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (5) Weed susceptibility chart, University of California, Co-operative Extension program, Ed. D Cudney (2000).
- (6) Luxan BV, Luxan MCPA 500 product label.



## MCPB

(eg *Butoxone*; soluble concentrate)

### Summary

MCPB is a selective, post-emergent, systemic, phenoxyacetic acid herbicide; available as a single active product or in mixtures (eg with MCPA). It is absorbed by the leaves and roots and translocated. In products it is present as the sodium salt. Although MCPB degrades relatively quickly in soil, it is potentially mobile, and moderately toxic to aquatic organisms. Therefore, care should be taken to avoid application where MCPB could enter surface waters.

### Application scenarios

MCPB is approved for the control of annual and perennial broadleaved weeds in established grassland and rotational grass<sup>1</sup>. Weeds should be actively growing at application, which should optimally take place when annual weeds are at the seedling stage and when the flower buds are forming in perennial weeds<sup>2</sup>. For established grasslands application can be in the spring, summer and early autumn when the weeds are growing vigorously and not shielded by grass<sup>2</sup>. Application is as a foliar spray, using tractor-mounted spraying equipment or knapsack and other hand-held sprayers, as appropriate.

### Fate in soil

MCPB is reported to degrade rapidly in soil, with a DT<sub>50</sub> range of 5-7 days. MCPB is soluble in water (4.4 g l<sup>-1</sup> for the acid at pH7)<sup>3</sup>. No data are available on the strength of the binding of MCPB to soil, but it is likely to be mobile. Despite this, its fast degradation and application timing reduces the likelihood of contamination of groundwater.

### Fate in water

MCPB does not degrade rapidly by chemical processes in aqueous environments<sup>3</sup>. However, it may be susceptible to degradation in water through the action of sunlight<sup>3</sup>. It has a low LogK<sub>ow</sub> (1.32 at pH7, for the acid)<sup>3</sup>, indicating a low bioaccumulation potential.

### Effects on terrestrial fauna

Generally, MCPB is regarded as slightly toxic to mammals<sup>3</sup>, with an acute oral LD<sub>50</sub> in the rat of 4,700 mg kg<sup>-1</sup> and acute inhalation LC<sub>50</sub> in the rat of >1.14 mg l<sup>-1</sup>. It is an eye irritant but not a skin irritant<sup>3</sup>. The sodium salt of MCPB is moderately toxic to birds (oral LD<sub>50</sub> for quail 282 mg kg<sup>-1</sup>)<sup>3</sup> and is non-toxic to bees (oral LD<sub>50</sub> >25 mg per bee)<sup>3</sup>.

### Effects on aquatic fauna

The sodium salt of MCPB has been found to be of moderate toxicity to aquatic fauna<sup>3</sup> with LC<sub>50</sub> values of 4.3 mg l<sup>-1</sup> for trout and 55 mg l<sup>-1</sup> for water fleas, and of moderate to high toxicity to algae (EC<sub>50</sub> of 0.42 mg l<sup>-1</sup> for *Selenastrum capricornutum*, 1.5 mg l<sup>-1</sup> for *Skeletonema costatum* and 0.71 mg l<sup>-1</sup> for *Navicula pelliculosa*)<sup>3</sup>.

### Effects on non-target plants

Application of MCPB will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to minimise such drift. Likewise, drift into natural watercourses close to the application area could also result in damage to non-target aquatic plants (EC<sub>50</sub> for fat duckweed of 0.23 mg l<sup>-1</sup>)<sup>3</sup>.

### Efficacy/safety<sup>2</sup>.

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible (as seedlings):

**Pteridophytes:** Marsh horsetail.

**Daisy family (Asteraceae):** Creeping thistle, spear thistle.

**Cabbage family (Brassicaceae):** Black mustard, field penny-cress, shepherd's-purse.

**Other dicotyledons:** Broad-leaved dock, buttercups, crowfoot, curled dock, fat-hen, greater plantain, hoary plantain, ribwort plantain, small nettle.

#### Moderately susceptible (as seedlings):

**Pteridophytes:** Field horsetail.

**Daisy family (Asteraceae):** Prickly sow-thistle, smooth sow-thistle.

**Cabbage family (Brassicaceae):** Charlock, treacle mustard, white mustard.

**Other dicotyledons:** Common fumitory, common hemp-nettle, common poppy, field bindweed.

#### Moderately resistant (as seedlings):

**Daisy family (Asteraceae):** Perennial sow-thistle.

**Cabbage family (Brassicaceae):** Wild turnip.

**Other dicotyledons:** Common orache, knotgrass, scarlet pimpernel.

#### Resistant:

**Grasses:** Bermuda-grass, various N American brome grasses, canary-grass, rye-grass.

**Daisy family (Asteraceae):** Corn marigold, dandelion, groundsel, mayweeds.

**Cabbage family (Brassicaceae):** Swine-cress.

**Other dicotyledons:** Black bindweed, cleavers, clover, corn spurrey, dodder, ivy-leaved speedwell, parsley-piert, red dead-nettle.

#### Livestock withholding period

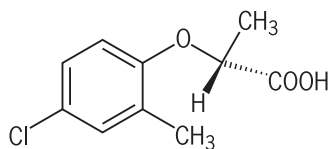
Normally – until foliage of poisonous weeds such as ragwort has died and become unpalatable.

Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Headland Agrochemicals UK Ltd. *Butoxone* product label.
- (3) Tomlin, C D S. 2000. The pesticide manual. A world compendium. 12th edition. BCPC, Surrey, UK.





### Summary

Mecoprop-P, available as its potassium (or dimethylamine) salt, is a selective, post-emergent, phenoxy acid herbicide; available as a single active product, or in mixtures. It is absorbed by foliage and translocated to the roots. Mecoprop-P degrades very rapidly in soil and so, despite being very mobile, is not expected to constitute a risk to groundwater. Movement to surface water is, though, possible. Mecoprop-P has slight mammalian toxicity and is not expected to adversely impact soil fauna. Every effort should be made to avoid contamination of watercourses.

### Application scenarios

Mecoprop-P is registered for the post-emergent control of certain broad-leaved weeds in established grasslands, amenity turf and newly sown leys<sup>1</sup>. Applications should be when the weeds are actively growing (and the soil moist and warm) and not shielded by the sward. Newly laid turf should not be treated until well established<sup>2,3</sup>. Generally, applications can be made from spring to early autumn<sup>3</sup>. Application can be by tractor-mounted sprayer or knapsack sprayer<sup>2</sup>.

### Fate in soil

Mecoprop-P is rapidly degraded in soil under laboratory conditions (DT<sub>50lab</sub> values of 7-19 days) and in the field (DT<sub>50field</sub> values of 5-17 days)<sup>4</sup>. Degradation under anaerobic conditions, however, was very slow<sup>4</sup>. Mecoprop-P is soluble in water (860 mg l<sup>-1</sup>)<sup>5</sup> and its salts are also very soluble (eg 920 g l<sup>-1</sup> for the potassium salt)<sup>5</sup>. Mecoprop-P and its salts are very weakly bound to soil (K<sub>oc</sub> values of 11-25)<sup>4</sup>. Therefore, there is a risk of leaching, which has been investigated in the field and found to be low in practice<sup>4</sup>. However, movement to surface water via run-off and drainage (especially immediately following application) is known to occur<sup>4</sup>.

### Fate in water

Mecoprop-P is hydrolytically stable, but is microbially degraded in the water phase with an overall DT<sub>50</sub> value of 14-30 days in natural water/sediment systems<sup>4</sup>. Mecoprop-P has a very low logK<sub>ow</sub> value (0.02) at pH7 and, therefore, has a low potential to bioaccumulate<sup>4</sup>.

## Mecoprop-P

(eg Duplosan KV, soluble concentrate)

### Effects on terrestrial fauna

Mecoprop-P (and its salts) has only slight mammalian toxicity<sup>5</sup>. In the rat it has an acute oral LD<sub>50</sub> of 1,050 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> of >4,000 mg kg<sup>-1</sup> and an inhalation LC<sub>50</sub> of >5.6 mg l<sup>-1</sup>.<sup>4</sup> It is an eye and skin irritant<sup>4</sup>. Mecoprop-P is moderately toxic to birds (LD<sub>50</sub> for duck >486 mg kg<sup>-1</sup>)<sup>4</sup> and non-toxic to bees (LC<sub>50</sub> >10 µg per bee)<sup>4</sup>. Mecoprop-P is not toxic to earthworms (LC<sub>50</sub> 14days 494 mg kg<sup>-1</sup>)<sup>5</sup> and is not toxic to a range of beneficial insects<sup>4</sup> and soil microbes.<sup>4</sup>

### Effects on aquatic fauna

Mecoprop-P has been found to be of low toxicity to fish (LC<sub>50</sub> 96h trout >150-220 mg l<sup>-1</sup>)<sup>5</sup>, water fleas (EC<sub>50</sub> 48hours >100 mg l<sup>-1</sup>)<sup>5</sup> and algae (*Selenastrum capricornutum* LC<sub>50</sub> 500 mg l<sup>-1</sup>; *P. subcapitata* LC<sub>50</sub> 270 mg l<sup>-1</sup>)<sup>5</sup>. However, given mecoprop-P's moderate persistence in water/sediment systems, care should be exercised when applying near to watercourses.

### Effects on non-target plants

Application of Mecoprop-P will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Care should be taken to avoid such non-target plants. Likewise, contamination of natural watercourses close to the application area could also result in damage to non-target aquatic plants (fat duckweed LC<sub>50</sub> of 60 mg l<sup>-1</sup>)<sup>5</sup>.

### Efficacy/safety<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, prickly lettuce, smooth sow-thistle, sunflower.

**Cabbage family (Brassicaceae):** Cabbage/rape, black mustard, charlock, field pennycress, garden radish, London-rocket, shepherd's purse, treacle mustard, white mustard.

**Other dicotyledons:** Amaranths, black nightshade, cleavers, common chickweed, common mouse-ear, common nettle, curled dock (seedlings), dandelion (seedlings), fat-hen, greater plantain, Japanese-lantern, leafy-fruited nightshade, nettle-leaved goosefoot, ribwort plantain, small nettle.

#### Moderately susceptible:

**Daisy family (Asteraceae):** Cudweed, dandelion, prickly sow-thistle, yellow star-thistle.

**Cabbage family (Brassicaceae):** Wild turnip.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Annual morning glory, common field speedwell, common fumitory, common orache, common purslane, corn buttercup, curled dock, dove's-foot cranesbill, fiddleneck, ivy-leaved speedwell, knotgrass, knotweeds, mallows, procumbent yellow-sorrel, red dead-nettle, ribwort plantain.

#### Moderately resistant:

**Daisy family (Asteraceae):** Groundsel, smooth sow-thistle, scentless mayweed.

**Other dicotyledons:** Black-bindweed, black nightshade, common poppy, cut-leaved cranesbill, common hemp-nettle, knotgrass, pale persicaria, redshank, scarlet pimpernel, viper's-bugloss.

#### Resistant:

**Pteridophytes:** Horsetail.

**Grasses:** Annual meadow-grass, autumn millet, barley, beetle-grass sp., Bermuda-grass, canary-grass, cocksbur, drooping brome, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, ripgut brome, sandburs, stink-grass, volunteer cereals, wild oat, yellow bristle-grass.

**Monocotyledons:** Galingales.

**Daisy family (Asteraceae):** Corn marigold, groundsel, pineappleweed, scented mayweed.

**Cabbage family (Brassicaceae):** Dittander, swine-cresses.

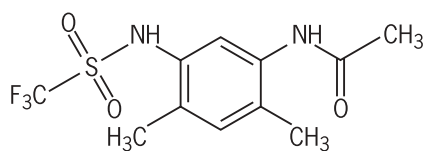
**Other dicotyledons:** Dodder, field bindweed, field forget-me-not, field pansy, henbit dead-nettle.

#### Livestock withholding period

Normally – at least 14 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) BASF Ltd., *Duplosan* KV 500 product label.
- (3) Headland Agrochemicals UK Ltd, *Optica*, product label.
- (4) PSD review report: on *Mecoprop-P*, No. 96 (1994).
- (5) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (6) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



# Mefluidide

(eg *Embark Lite*, soluble concentrate)

## Summary

Mefluidide, available as its diethanolamine salt, is a plant growth regulator and herbicide which inhibits growth and seed production in grasses and in ornamental trees and shrubs. It is absorbed by foliage. There are little data available in the public domain relating to the toxicity and environmental profile of mefluidide. Nevertheless, what is available suggests that mefluidide is of low mammalian toxicity and is expected to constitute a low risk to non-target flora and fauna, but care should be taken to avoid contamination of watercourses.

## Application scenarios

Mefluidide is registered for use as an inhibitor of growth and seed production in grass in amenity grasslands and amenity turf<sup>1</sup>. Applications should be when the grass has reached the appearance, height and density desired, before the onset of seed production<sup>5</sup> and when it is actively growing<sup>2</sup>. Generally, applications can be made from spring to autumn, but ideally in April-May. Rain within 8 hours of application will reduce its effectiveness<sup>2</sup>. Application can be by tractor-mounted sprayer or knapsack sprayer<sup>2</sup>.

## Fate in soil

Mefluidide is rapidly degraded in soil with a reported DT<sub>50</sub> of less than 1 week<sup>3</sup> (2 days<sup>4</sup>). Mefluidide is soluble in water (180 mg l<sup>-1</sup>) and its diethanolamine salt is likely to be very soluble. Mefluidide has a pKa value of 4.6<sup>3</sup>. Mefluidide is likely to be mobile but its fast degradation in soil will mitigate against contamination of groundwater. However, movement to surface water via run-off and drainage (especially immediately following application) is a possibility.

## Fate in water

No information is available regarding the fate of mefluidide in water. Mefluidide does, however, have a low logK<sub>ow</sub> value (2.02, unionised<sup>3</sup>) and, therefore, has a low potential to bioaccumulate.

## Effects on terrestrial fauna

Mefluidide has only slight mammalian toxicity<sup>3,4</sup>. It has an acute oral LD<sub>50</sub> in the rat of >4,000 mg kg<sup>-1</sup> and a dermal LD<sub>50</sub> in the rabbit of >4,000 mg kg<sup>-1</sup>. The inhalation LC<sub>50</sub> is >8.5 mg l<sup>-1</sup> in the rat<sup>4</sup>. It is a mild eye irritant but not a skin irritant<sup>3</sup>. Mefluidide is slightly toxic to birds (LD<sub>50</sub> for duck >4,620 mg kg<sup>-1</sup>)<sup>3</sup> and non-toxic to bees<sup>3</sup>.

## Effects on aquatic fauna

Mefluidide has been found to be of low toxicity to fish (LC<sub>50</sub> 96h trout >100 mg l<sup>-1</sup>)<sup>3</sup>. No other data relating to aquatic fauna are available, so care should be taken not to contaminate water courses.

## Effects on non-target plants

Application of mefluidide will pose a risk to susceptible plants outside of the target area where spray drift is possible, but it is to be expected that due to mefluidide's mode of action (growth inhibition) any effects would not be long lasting.

## Efficacy/safety<sup>2,5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Annual meadow-grass, Bermuda-grass, black bent, common bent, creeping bent, crested dog's-tail, perennial ryegrass, smooth meadow-grass, red fescue, tall fescue, Timothy, Yorkshire-fog.

**Dicotyledons:** Barberry, Elaeagnus, spindle, fig, bladder ketmia, holly, iceplant/sea-fig, ivy, jasmine, laurel, oleander, Osmanthus, Photinia, pittosporum, plain treasureflower, Podocarpus, privet, firethorn, viburnum.

#### Resistant:

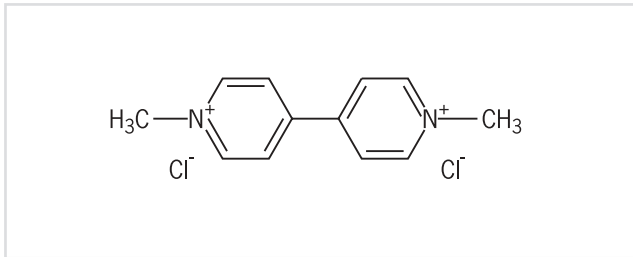
**Grasses:** Common couch, cock's-foot.

#### Livestock withholding period

Normally - no grazing allowed at all. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Intracrop., *Embark* product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Exttoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (5) PBI/Gordon, *Embark* product label (USA).



## Paraquat (dichloride)

(eg Gramoxone 100; soluble concentrate)

### Summary

Paraquat is a non-selective, post-emergent, quaternary ammonium, contact herbicide, available as a single active product or as a mixture with diquat. It is absorbed through foliage. Despite being very water soluble, paraquat binds very tightly to soil and sediments. It is toxic to mammals (including humans) and other wildlife, but is very rapidly inactivated on contact with soil and plants and not expected to adversely impact soil and aquatic fauna, when used according to the label. Great care should be taken to avoid spray drift into watercourses.

### Application scenarios

Paraquat is registered for the control of weeds in forestry, non-crop areas, field margins, stubbles, orchards and sward destruction in grasslands<sup>1,2</sup>. Treatments are effective at any time of the year, with faster action in the spring/summer, but longer lasting effects in the winter. Treatments can be made either by tractor-mounted spray systems or knapsack sprayers.

### Fate in soil

Paraquat is known to degrade only very slowly in soil, if at all. It is extremely water soluble (620 g l<sup>-1</sup>)<sup>4</sup> but is also extremely tightly bound to soil (K<sub>d</sub> value of >10,000)<sup>4</sup>. Consequently, paraquat is completely immobile and will not move to groundwater. Once bound to soil, paraquat has been found to be completely non-available (physically and biologically)<sup>4</sup>.

### Fate in water

Paraquat is not susceptible to chemical hydrolysis or volatilisation. It does not bioaccumulate but does bind very rapidly, and tightly, to sediment and particulate matter suspended in the water (eg soil and decaying vegetable matter).

### Effects on terrestrial fauna

Generally, paraquat is regarded as toxic with an oral LD<sub>50</sub> in the rat of 129-157 mg kg<sup>-1</sup><sup>4</sup>, dermal LD<sub>50</sub> in the rabbit of 236-325 mg kg<sup>-1</sup><sup>5</sup> and inhalation LC<sub>50</sub> in the rat of 1 mg l<sup>-1</sup><sup>3</sup>. Paraquat, if swallowed, is also toxic (and potentially lethal) to humans and is subject to specific requirements under the Poisons Act 1972 and Poisons Rules 1982. It is irritating to skin and eyes<sup>4</sup>. Paraquat is moderately toxic to birds (oral LD<sub>50</sub> for ducks 175 mg kg<sup>-1</sup>)<sup>4</sup> but non-toxic to bees (oral LD<sub>50</sub> 36 mg per bee)<sup>4</sup> and

worms (LC<sub>50</sub> >1,380 mg kg<sup>-1</sup>)<sup>4</sup>. Paraquat can be harmful to hares and stubble should therefore be sprayed early in the day<sup>2</sup>.

### Effects on aquatic fauna

Paraquat has been found to be moderately toxic to fish<sup>4</sup> (LC<sub>50</sub> for rainbow trout 26 mg l<sup>-1</sup>) and water fleas<sup>4</sup> (EC<sub>50</sub> 48 hours 6.1 mg l<sup>-1</sup>). Paraquat is very toxic to *Navicula pelliculosa* (EC<sub>50</sub> 0.4 mg l<sup>-1</sup>)<sup>3</sup> but its tight binding to soil/sediment and suspended particles substantially mitigates the risk to such organisms.

### Effects on non-target plants

Paraquat is a non-selective herbicide and care should therefore be taken not to over-spray desired plants and to reduce spray drift onto such plants. Aquatic plants are sensitive to paraquat (fat duckweed EC<sub>50</sub> 71 mg l<sup>-1</sup>)<sup>3</sup> and great care should be taken to avoid spray drift into natural watercourses.

### Efficacy/safety<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Annual meadow grass, barren brome, black bent, blackgrass, cocksfoot, common couch, creeping bent, creeping soft grass, finger-grasses, Italian rye-grass, Johnson-grass (seedlings), perennial rye-grass, red fescue, rough meadow-grass, tall fescue, Timothy, wild oats, yellow bristle-grass, Yorkshire fog.

**Daisy family (Asteraceae):** Cocklebur, groundsel, mayweeds, yellow star-thistle.

**Cabbage family (Brassicaceae):** Cabbage/ rape, charlock, field penny-cress, garden radish, London-rocket, mustard, shepherd's-purse, swine-cresses.

**Other dicotyledons:** Amaranths, annual nettle, black bindweed, black nightshade, cleavers, common chickweed, common fumitory, common hemp-nettle, common orache, common poppy, common purslane, corn spurrey, curled dock, fat-hen, field pansy, forget-me-not, henbit dead-nettle, Japanese-lantern, knotgrass, leafy-fruited nightshade, nettle-leaved goosefoot, pale persicaria, parsley-piert, pigweed, red dead-nettle, redshank, ribwort plantain (seedlings), speedwells, summer-cypress, velvetleaf.

#### Moderately susceptible:

**Grasses:** Annual meadow-grass, barley, Bermuda-grass (seedlings), canary grass, cockspur, drooping brome, Italian rye-grass, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass.

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, pineappleweed, prickly lettuce, smooth sow-thistle, sunflower.

**Cabbage family (Brassicaceae):** Shep-herd's purse.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Annual morning glory, common nettle, fiddleneck, field bindweed (seedlings), knotgrasses, knotweeds, procumbent yellow-sorrel, stork's-bills, thorn-apples.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Beetle-grass sp.

**Other monocotyledons:** Galingales.

**Daisy family (Asteraceae):** Cudweed, dandelion.

**Cabbage family (Brassicaceae):** Dittander.

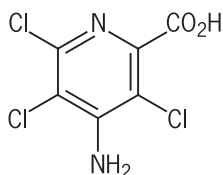
**Other dicotyledons:** Curled dock (established), dodder, mallows.

#### Livestock withholding period

Normally – keep livestock out for at least 24 hours and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Syngenta Ltd. *Gramoxone 100* product label.
- (3) US-EPA RED document, EPA 738-F-96-018 (1997).  
([www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm)).
- (4) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (5) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (6) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).



# Picloram

(Tordon 22K; soluble concentrate)

## Summary

Picloram is a selective systemic pyridine herbicide, absorbed rapidly by roots and leaves and translocated in the plant both acropetally (up) and basipetally (down). It is available as a single active product or in mixtures with 2,4-D or bromacil. It is very water soluble and moderately persistent in the environment. As such, picloram constitutes a risk to ground- and surface-water. It has low toxicity to mammals and other wildlife but is moderately toxic to aquatic fauna. Given its high mobility in soil, picloram should not be applied to areas from which it can easily move into surface waters or areas where non-target plants would be affected (eg on slopes or near to watercourses).

## Application scenarios

Picloram K-salt (potassium salt) is registered for the control of a wide range of deep-rooted perennial and herbaceous weeds and for the control of woody weeds and scrub, on land not intended for cropping<sup>1,2</sup>. For non-crop, non-grass areas the best treatment time is late winter or early spring which will prevent development of most broad-leaved species for the rest of the season. For non-crop, grass areas treatment should coincide with periods of vigorous growth<sup>2</sup>. Treatments can be made either by tractor-mounted spray systems or knapsack and other hand-sprayers.

## Fate in soil

Picloram is known to degrade only moderately slowly in soil, with laboratory DT<sub>50</sub> values of 30-90 days<sup>4</sup>. Picloram is thought to be susceptible to degradation on soil surfaces through the action of sunlight<sup>4</sup>. It is water soluble (430 mg l<sup>-1</sup>)<sup>4</sup> with the K-salt being extremely water soluble (200 g l<sup>-1</sup>)<sup>4</sup> and is only moderately tightly bound to soil (K<sub>d</sub> values <1)<sup>3</sup>.

Consequently, movement of picloram to groundwater must be considered as reasonably likely. Furthermore, there is also a risk of movement of picloram to surface water via run-off and drainage.

## Fate in water

Picloram is not susceptible to chemical hydrolysis or loss through volatilisation, but is thought to degrade in aqueous environments through the action of sunlight<sup>4</sup>. Picloram has a low LogK<sub>ow</sub> value (1.9 at pH<1)<sup>4</sup>, which will be even lower for the K-salt, therefore there is a low risk of bioaccumulation.

## Effects on terrestrial fauna

Generally, picloram is regarded as moderately toxic to mammals with an oral LD<sub>50</sub> in the rat of >5,000 mg kg<sup>-1</sup><sup>4</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup><sup>3</sup> and inhalation LC<sub>50</sub> in the rat of >1.65 mg l<sup>-1</sup> (for the K-salt)<sup>3</sup>. It is moderately irritating to the eye<sup>4</sup> and mildly irritating to the skin<sup>4</sup>. Picloram is of low toxicity to birds (oral LD<sub>50</sub> for ducks >5,000 mg kg<sup>-1</sup>)<sup>4</sup> and is non-toxic to bees (oral LD<sub>50</sub> >100 mg per bee)<sup>3</sup> and worms<sup>4</sup>.

## Effects on aquatic fauna

Picloram has been found to be moderately toxic to fish (K-salt LC<sub>50</sub> 96 hours for rainbow trout 26 mg l<sup>-1</sup>)<sup>4</sup> and slightly toxic to water fleas (K-salt LC<sub>50</sub> 63.8 mg l<sup>-1</sup>)<sup>4</sup>. Picloram is slightly toxic to algae (EC<sub>50</sub> for *Selenastrum capricornutum* 36.9 mg l<sup>-1</sup>)<sup>4</sup>. Movement of picloram into surface waters, therefore, may have an adverse effect.

## Effects on non-target plants

When applying picloram, because of its persistence and mobility, it is important that spray drift is not permitted to contaminate crop land or irrigation water or to drift onto or within the root zone of crops, hedges or fruit, ornamental or forest trees or gardens<sup>2</sup>.

Although no data are available on the susceptibilities of aquatic plants to picloram, it is best to assume that any exposure to picloram would have an adverse affect.

## Efficacy/safety<sup>2</sup>

See table overleaf.



**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Ferns:** Bracken.

**Daisy family (Asteraceae):** Burdocks, cat's-ear, colt's-foot, common ragwort, cotton thistle, creeping thistle, dandelion, hawkweed, mugwort, tansy, yarrow.

**Pea family (Fabaceae):** Common bird's-foot trefoil, white clover.

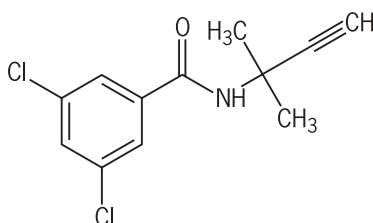
**Other dicotyledons:** Bramble, common chickweed, common nettle, creeping buttercup, creeping cinquefoil, docks, field bindweed, hogweed, Japanese knotweed, plantains, rosebay willowherb, silverweed, wild mignonette.

#### Livestock withholding period

Normally – keep livestock out for at least 24 hours and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Nomix-Chipman Ltd. *Tordon 22k* technical datasheet.
- (3) US-EPA RED document, EPA 738-R-95-019 (1995).  
([www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm)).
- (4) Tomlin, C D S. 2000. *The pesticide manual*.  
*A world compendium*. 12th edition. BCPC, Surrey, UK.



# Propyzamide

(eg *Kerb Pro Flo*, suspension concentrate)

## Summary

Propyzamide is a selective, systemic, pre- or post-emergent amide herbicide. It is absorbed through the roots and translocated. Propyzamide is of low mammalian toxicity and is expected to constitute a low risk to non-target flora and fauna, but is known to be persistent in soil and water. Care should be taken to avoid contamination of water courses.

## Application scenarios

Propyzamide is registered for the control of grasses and broad-leaved weeds in amenity vegetation (trees, shrubs, and ornamental plants) and forestry<sup>1</sup>. Applications can be made at any time between the beginning of October and the end of February<sup>2</sup>. Best residual activity is obtained in moist, cold soils, when soil temperatures are falling and are expected to remain low<sup>2</sup>. Application can be by tractor-mounted sprayer or knapsack sprayer<sup>2</sup>.

## Fate in soil

There are little data available relating to the fate of propyzamide in soil<sup>4</sup>. It appears to be degraded more quickly in the field than in the laboratory<sup>4</sup> but residual herbicide activity is claimed for up to 6 months after application<sup>3</sup>. Propyzamide may be susceptible to degradation in soil through the action of sunlight<sup>4</sup>. Propyzamide is sparingly soluble in water (15 mg l<sup>-1</sup>)<sup>4</sup> and tightly bound to soil (K<sub>oc</sub> values of 548-1340)<sup>4</sup> and is not expected to contaminate groundwater, despite its potential soil persistency. However, one of its major soil metabolites is possibly mobile (K<sub>oc</sub> range of 96-210)<sup>4</sup>.

## Fate in water

Propyzamide is hydrolytically stable, but may be susceptible to degradation in water through the action of sunlight. However, propyzamide may be persistent in water<sup>4</sup>. Propyzamide has a relatively high logK<sub>ow</sub> value (3.2<sup>3</sup>) and, therefore, has a potential to bioaccumulate.

## Effects on terrestrial fauna

Propyzamide has only slight mammalian toxicity<sup>4</sup>. It has an acute oral LD<sub>50</sub> in the rat of 5,620 mg kg<sup>-1</sup> and a dermal LD<sub>50</sub> in the rabbit of >3,160 mg kg<sup>-1</sup><sup>4</sup>. The inhalation LC<sub>50</sub> is >3.2 mg l<sup>-1</sup> in the rat<sup>4</sup>. It is a mild eye and skin irritant<sup>3</sup>. Propyzamide is of low toxicity to birds (LD<sub>50</sub> for quail 8,770 mg kg<sup>-1</sup>)<sup>4</sup> and non-toxic to bees (LD<sub>50</sub> >100 µg per bee<sup>3</sup>). Toxicity to earthworms is low (LC<sub>50</sub> >346 mg kg<sup>-1</sup>)<sup>3</sup>.

## Effects on aquatic fauna

Propyzamide is slightly toxic to fish (LC<sub>50</sub> 96h trout 72 mg l<sup>-1</sup>) but this exceeds the water solubility<sup>3</sup>. Propyzamide may be moderately toxic to water fleas (LC<sub>50</sub> >5.6 mg l<sup>-1</sup>)<sup>4</sup> but the low water solubility made testing difficult. Propyzamide is toxic to algae (EC<sub>50</sub> of 0.76 mg l<sup>-1</sup> for *Selenastrum capricornutum*)<sup>4</sup>. Care should be taken not to contaminate watercourses.

## Effects on non-target plants

Application of propyzamide will pose a risk to susceptible plants outside of the target area, where spray drift is possible. Likewise, contamination of natural watercourses close to the application area could also result in damage to non-target aquatic plants (although no data are available on the susceptibility of aquatic plants to propyzamide).

## Efficacy/safety<sup>2,5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Grasses:** Annual meadow-grass, autumn millet, barren brome, beetle-grass, blackgrass (seedlings), canary-grass, cockspur, common bent, common couch, creeping soft-grass (seedlings), downy brome, hairy finger-grass, rescue grass, ripgut brome, volunteer cereals, yard-grass, yellow bristle-grass, love-grass, rye-grass, sweet vernal grass, tufted hair-grass, wild oat, Yorkshire fog.

**Daisy family (Asteraceae):** Tansy.

**Cabbage family (Brassicaceae):** London rocket, mustard.

**Other dicotyledons:** Black bindweed, black nightshade, common chickweed, common nettle, creeping buttercup, fat-hen, fiddleneck, goosefoot, henbit, knotgrass, Japanese-lantern, leafy-fruited nightshade, pigweed, purslane, redshank, small nettle, speedwells, summer-cypress.

#### Moderately susceptible:

**Pteridophytes:** Field horsetail.

**Grasses:** Blackgrass (established), creeping soft-grass (established)

**Other monocotyledons:** Sedges.

**Cabbage family (Brassicaceae):** Shep-herd's purse (seedlings), wild radish.

**Other dicotyledons:** Broad-leaved dock, common fumitory (seedlings), creeping buttercup, dodder, mallow, prostrate spurge, sheep's sorrel.

#### Moderately resistant:

**Grasses:** Cock's-foot (established).

**Dicotyledons:** Cleavers (seedlings).

#### Resistant:

**Pteridophytes:** Horsetails.

**Monocotyledons:** Purple nutsedge, yellow nutsedge.

**Daisy family (Asteraceae):** Argentine fleabane, Canadian fleabane, cocklebur, creeping thistle, cudweed, dandelion, gallant-soldier, groundsel, mayweed, prickly lettuce, ragwort, sow-thistle, sunflower, yellow star-thistle.

**Cabbage family (Brassicaceae):** Dittander, shepherd's purse (established), swine cress.

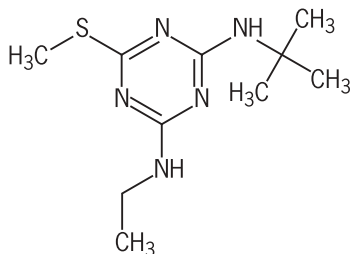
**Other dicotyledons:** Bindweed, Thorn-apples, cleavers (established), clover, common nettle, common fumitory (established), common poppy, filaree, foxglove, hemp-nettle, plantains, red dead-nettle, rosebay willow-herb, scarlet pimpernel.

#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) SumiAgro (UK) Ltd, Kerb Pro Flo product label.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Pronamide; US-EPA RED, EPA-738-R-94-007 (1994).  
[www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm).
- (5) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).
- (6) Interfarm (UK) Ltd, Kerb 50 W product label.



## Terbutryn

(eg Clarosan; slow release granule)

**NB:** This herbicide is withdrawn from sale on 24 July 2003 and last day of use is 31 December 2003, as a result of the EC review of approved pesticides. The manufacturer has not supported its continued use.

### Summary

Terbutryn is a selective methylthiotriazine herbicide, absorbed by roots and foliage and translocated acropetally (up) through the xylem. It is used to control aquatic weeds in static and slow moving water-bodies. It has low mammalian toxicity and moderate toxicity to aquatic fauna. Terbutryn is strongly adsorbed to soil and sediments and this, together with the application rate/formulation type, leads to a low risk of adverse effects on aquatic fauna.

### Application scenarios

Terbutryn is registered for the control of aquatic, submerged and free-floating weeds and algae in watercourses, reservoirs and fish ponds (static and slow moving water bodies, flow rate <1 metre per 3 minutes)<sup>1,2</sup>. Terbutryn is provided as a controlled release formulation. This maintains a satisfactory dosage level in static water, such that re-growth should not occur for at least 3-4 months following treatment (which can be from April/May up to August, for lakes, canals and ditches; and by the end of April for small ponds)<sup>2</sup>. In cases of heavy infestations, the water body should be treated in strips with at least 14 days between applications.

### Fate in soil

Terbutryn degrades moderately quickly in soil (laboratory aerobic DT<sub>50</sub> values of 14-50 days)<sup>3</sup> but very much less rapidly in the sediment of ponds and rivers (DT<sub>50</sub> values of 180-240 days)<sup>4</sup>. It has a low water solubility (22 mg l<sup>-1</sup>)<sup>3</sup> and is strongly bound to soil and sediment (K<sub>oc</sub> of 2,000)<sup>3</sup>. As such, terbutryn is not a risk to groundwater.

### Fate in water

Terbutryn is not hydrolysed, but is thought to be degraded through the action of sunlight<sup>3</sup>. The most significant dissipation route for terbutryn in water systems is its strong adsorption onto sediment and suspended particles<sup>3</sup>.

### Effects on terrestrial fauna

Generally, terbutryn is regarded as slightly toxic to mammals<sup>3,4</sup> with an oral LD<sub>50</sub> in the rat of 2,500 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >2,200 mg m<sup>-3</sup>. It is not irritating to eyes or skin<sup>3</sup>. Terbutryn has low toxicity to birds (oral LD<sub>50</sub> for ducks >4,640 mg kg<sup>-1</sup>)<sup>3</sup> and is non-toxic to bees (oral LD<sub>50</sub> >225 mg per bee)<sup>3</sup> and worms (LC<sub>50</sub> 170 mg kg<sup>-1</sup>)<sup>3</sup>.

### Effects on aquatic fauna

Terbutryn has been found to be moderately toxic to fish (LC<sub>50</sub> 96 hours for rainbow trout of 1.1 mg l<sup>-1</sup> and for carp of 1.4 mg l<sup>-1</sup>)<sup>3</sup> and moderately toxic to water fleas (LC<sub>50</sub> 48 hours 2.66 mg l<sup>-1</sup>)<sup>3</sup>. Terbutryn is toxic to algae (EC<sub>50</sub> for *Selenastrum capricornutum* 0.013 mg l<sup>-1</sup>)<sup>3</sup>. Excessive decaying vegetation, following successful treatment in aquatic areas can lead to oxygen depletion and indirect adverse effects on fish, and measures should be taken to prevent such a situation from occurring.

**Given the moderate toxicity to aquatic species it is especially important to follow the recommended application rates carefully, which have been selected to balance efficacy against adverse ecological effects.**

### Effects on non-target plants

When applying herbicides to water bodies it is especially important that good agricultural practices are adhered to.

### Efficacy/safety<sup>2,5</sup>

See table overleaf.

**Important note:** The table below is intended only as an **indication** of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Algae:** Bladder-weed, blanket weeds.

**Monocotyledons:** Canadian waterweed, curled pondweed, duckweeds, fennel pondweed.

**Dicotyledons:** Rigid hornwort, water-crowfoots, water-mil-foils, water-starworts, water-violet.

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#### Moderately resistant:

**Algae:** Cott.

**Monocotyledons:** Broad-leaved pondweed.

**Dicotyledons:** Mare's-tail, water lilies, white water lily.

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#### Resistant:

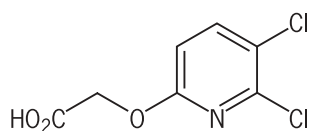
**Dicotyledons:** Amphibious bistort.

#### Livestock withholding period

Normally – none quoted. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
[www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm).
- (2) The Scotts Company (UK) Ltd. *Clarasan* technical datasheet.
- (3) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (4) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (5) Aquatext. Herbicide susceptibility key.  
([www.aquatext.com/tables/herbsusc](http://www.aquatext.com/tables/herbsusc)).



# Triclopyr

(eg *Chipman Garlon 4*; emulsifiable concentrate)

## Summary

Triclopyr is a selective, systemic, pyridine herbicide. It is rapidly absorbed by the foliage and roots and translocated throughout the plant. Triclopyr is available as a single active product. It is present as a salt or ester in products, both of which rapidly transform to the acid, in environmental compartments. Triclopyr is water soluble and moderately persistent in soil and constitutes a slight risk to groundwater. Its main soil metabolite is more persistent and mobile, and the risk of groundwater contamination is greater. Generally, triclopyr has low toxicity to mammals and other wildlife but its derivatives and main metabolite are moderately toxic to aquatic fauna. **Given its mobility in soil, triclopyr-derivatives should not be applied to areas from which they can move into surface waters or areas where non-target plants would be affected (eg on slopes, and near to watercourses).**

## Application scenarios

Triclopyr is registered for the control of perennial broadleaved weeds, brambles, docks, scrub, common nettle and woody weeds, on land not intended for cropping, established grassland and forestry<sup>1,2</sup>. It can also be used to control unwanted standing coppice or scrub and for the prevention of shoot growth on cut stumps<sup>2</sup>. For non-crop grass areas treatment should be in the summer<sup>2</sup>. For the control of tree shoots, application is best in the winter<sup>2</sup>. Tree stem treatments (basal bark spray, frill girdling and tree injection) are best carried out in late summer<sup>2</sup>. Treatments can be made either by tractor-mounted spray systems or knapsack and other hand-held sprayers, and also by tree stem treatment methods. Application is not permitted within 6 metres of susceptible crops, ponds, lakes or watercourses, when using tractor-mounted boom sprayers; or within 2 metres of ponds, lakes or watercourses when using hand-held sprayers<sup>2</sup>.

## Fate in soil

Triclopyr-derivatives (salts and esters) very rapidly convert/hydrolyse to the acid with DT<sub>50</sub> values of <1 day<sup>3</sup>. The acid is degraded under aerobic conditions moderately quickly (DT<sub>50</sub> values between 30-90 days; mean 46 days<sup>4,5</sup>) but the main soil metabolite is more persistent. Under anaerobic conditions the acid is much more persistent (DT<sub>50</sub> values >2 years<sup>3</sup>). The acid is water soluble (8.1 g l<sup>-1</sup> at pH7) and is only moderately tightly bound to soil (K<sub>oc</sub> value of 59)<sup>4</sup>. The main soil metabolite is more mobile. Consequently, movement of the acid to groundwater must

be considered as possible and that of the metabolite as reasonably likely. Furthermore, there is also a risk of movement of triclopyr and the metabolite to surface water via run-off and drainage.

## Fate in water

Triclopyr-derivatives convert/degrade very rapidly to the acid in water environments (DT<sub>50</sub> values <1 day)<sup>3</sup>. The acid is degraded rapidly through the action of sunlight<sup>4</sup>. The main water metabolite is more persistent than the acid. As triclopyr acid, and its metabolite, have low LogK<sub>ow</sub> values (-0.45 at pH7 for the acid)<sup>4</sup>, there is a low risk of bioaccumulation.

## Effects on terrestrial fauna

Generally, triclopyr and its derivatives are of low mammalian toxicity<sup>3,4</sup> with oral LD<sub>50</sub> values in the rat of >500 mg kg<sup>-1</sup>, dermal LD<sub>50</sub> in the rabbit of >2,000 mg kg<sup>-1</sup> and inhalation LC<sub>50</sub> in the rat of >2.6 mg l<sup>-1</sup>. The salt, however, is corrosive to the eye<sup>3</sup> and both the salt and ester are skin sensitisers<sup>3</sup>. Triclopyr and its derivatives are of low toxicity to birds (oral LD<sub>50</sub> for ducks 1,698 mg kg<sup>-1</sup>)<sup>4</sup> and non-toxic to bees (oral LD<sub>50</sub> >100 mg per bee)<sup>4</sup>.

## Effects on aquatic fauna

Although the triclopyr acid and salt are non-toxic to fish (LC<sub>50</sub> 96 hours 117 mg l<sup>-1</sup>)<sup>4</sup> and to water fleas (LC<sub>50</sub> 133 mg l<sup>-1</sup>)<sup>4</sup> the ester and metabolite are moderately toxic to both (LC<sub>50</sub> for fish 0.36-2.7 mg l<sup>-1</sup> and for water fleas 12 mg l<sup>-1</sup>)<sup>3</sup>. Likewise, triclopyr acid is less toxic to algae (EC<sub>50</sub> for *Selenastrum capricornutum* 45 mg l<sup>-1</sup>)<sup>4</sup> than the derivatives (EC<sub>50</sub> for the ester for *Selenastrum capricornutum* 3.4 mg l<sup>-1</sup>)<sup>3</sup>.

## Effects on non-target plants

When applying triclopyr, because of its persistence and mobility, it is important that spray drift is not permitted to contaminate crop land or irrigation water, or to drift onto or within the root zone of susceptible non-target plants. Sitka spruce, Norway pine, Douglas fir, larch and other conifers are susceptible to damage when not completely dormant. Aquatic plants are also susceptible (eg fat duckweed EC<sub>50</sub> 0.88 mg l<sup>-1</sup>)<sup>3</sup>.

## Efficacy/safety<sup>2,6</sup>

See table overleaf.

**Important note:** The table below is intended only as an indication of relative species' sensitivities to this herbicide. The information used was not necessarily based upon objective, scientific data. **DO NOT ASSUME THAT A NON-TARGET SPECIES WILL BE SAFE FROM DAMAGE, JUST BECAUSE THIS TABLE LISTS IT AS 'RESISTANT'. ALWAYS READ THE PRODUCT LABEL.**

#### Susceptible:

**Trees & shrubs:** Alders, apple, ash, beech, birches, blackthorn, box, briar, broom, buckthorn, dogwood, elder, elms, false acacia, field maple, gorse, hawthorn, hazel, hornbeam, horse chestnut, laurel, lilac, limes, oaks, pear, poplars, privet, rhododendron, rock-roses, rosemary, rowan, St Lucie Cherry, sweet chestnut, sycamore, wild cherry, wild pear, willows.

**Daisy family (Asteraceae):** Canadian fleabane, dandelion, goldenrod, groundsel, mouse-ear hawk-weed, prickly lettuce, smooth sow-thistle, sunflower.

**Cabbage family (Brassicaceae):** Cabbage/rape, garden radish, London-rocket, shepherd's purse.

**Pea family (Fabaceae):** Medicks, melilots.

**Other dicotyledons:** Amaranths, black nightshade, bramble, common chickweed, cross-leaved heath, curled dock (seedlings), fat-hen, field bindweed (seedlings), ground-elder, Japanese-lantern, heather, honeysuckle, leafy-fruited nightshade, nettles, nettle-leaved goosefoot, perforate St John's-wort, primrose, procumbent yellow-sorrel, rosebay willowherb, tormentil, violets, wild strawberry.

#### Moderately susceptible:

**Trees & shrubs:** Cornelian-cherry, ever-green oak, Midland hawthorn, wayfaring tree.

**Daisy family (Asteraceae):** Yellow star-thistle.

Other dicotyledons: Curled dock (established), field bindweed, old man's beard, ribwort plantain, stork's-bills.

#### Resistant:

**Pteridophytes:** Horsetails.

**Grasses:** Annual meadow-grass, autumn millet, beetle-grass sp., barley, Bermuda-grass, canary-grass, cockspur, common bent, drooping brome, false oat-grass, finger-grasses, Italian rye-grass, Johnson-grass, rescue brome, ripgut brome, sheep's fescue, smooth meadow-grass, sandburs, stink-grass, volunteer cereals, wild oat, yard-grass, yellow bristle-grass, Yorkshire-fog.

**Other monocotyledons:** Field wood-rush, galingales.

**Daisy family (Asteraceae):** Smooth hawk's-beard.

**Cabbage family (Brassicaceae):** Dittander.

**Other dicotyledons:** Dodder, mallows, sheep's sorrel.

#### Livestock withholding period

Normally – at least 7 days and until foliage of poisonous weeds such as ragwort has died and become unpalatable. Check the label.

#### References

- (1) UK Pesticides Safety Directorate.  
([www.pesticides.gov.uk/raid\\_info/bbcrop-fp.cfm](http://www.pesticides.gov.uk/raid_info/bbcrop-fp.cfm)).
- (2) Nomix- Chipman Ltd. *Chipman Garlon 4* technical datasheet.
- (3) US-EPA RED document, EPA 738-R-98-011 (1998).  
([www.epa.gov/pesticides/reregistration/status.htm](http://www.epa.gov/pesticides/reregistration/status.htm)).
- (4) Tomlin, C D S. 2000. *The pesticide manual. A world compendium*. 12th edition. BCPC, Surrey, UK.
- (5) Extoxnet:  
(<http://pmep.cce.cornell.edu/profiles/index.html>).
- (6) *Weed susceptibility chart*, University of California, Co-operative Extension program, Ed. D Cudney (2000).