A grower guide

Hardy Nursery Stock

Practical weed control for nursery stock

Fully revised 2013

John Atwood, ADAS

Contents

Weed control in field-grown nursery stock

Appendices

Introduction

Achieving consistent good weed control without crop damage is one of the major challenges facing the nursery stock grower. The HDC has recognised this and has invested heavily in weed control research in nursery stock.

This guide is intended to summarise information on weed control in nursery stock in an easy-to-use format. It should provide both a quick guide to formulating weed control programmes as well as providing more in-depth reference data. It should be useful for both spray operators and nursery managers.

The data sources for this guide include HDC research projects, manufacturers' data and best commercial practice. However as a result of the wide range of nursery stock grown and the sensitivity of some species to herbicides, it is inevitable that crop damage can occur from time to time even when trials have indicated a herbicide to be non-damaging on some species and varieties. Unfortunately the number of herbicides with label recommendations for nursery stock is limited and is diminishing as manufacturers are increasingly unwilling to take the risk of claims for crop damage.

To be of practical use this guide refers to some off-label herbicide uses which have been included as treatments in HDC trials. Such information is provided in good faith but must be regarded as a guide rather than a definitive recommendation as any such usage is at the grower's own risk.

Section 1: **Principles of weed control**

Principles of weed control in container nurseries

Introduction

Weed control is an important element of container-grown nursery stock production. The moist, fertile conditions provided for container plants are also ideal for weed germination and growth throughout most of the year.

Hand weeding is prohibitively expensive, at least thirty times more costly than an efficient herbicide programme, and rarely very effective on its own. The presence of even small weeds in containers can reduce the growth of the crop and render it unsightly. An increase in certification schemes with 'zero tolerance' for weeds may well result in weed infested pots becoming unsaleable.

When developing a weed control strategy it is important to consider the extent of the problem, the degree of control required, what other non-chemical measures can be used and, if herbicides are to be used, the safety and environmental implications of their use.

Herbicides however, will continue to play an important role in weed control of container-grown nursery stock, although the wide range of plant species grown and production under protection makes careful selection of herbicides important. The following sections consider the range of herbicides available and their uses, drawing on results of HDC and Defra funded ADAS trials work.

Weed control strategy

Planning

An initial review should be undertaken to assess the individual nursery circumstances. Key areas for consideration include:

- Nursery hygiene and current sources of weed.
- Weed spectrum and severity at each site.
- Crops grown and past experience of herbicide safety.
- Application equipment availability and suitability.
- Whether the COSHH assessment is up-to-date.
- Staff training and experience.

Following the review, a plan of action should first consider:

- Nursery hygiene measures to minimise weed spread onto and within the nursery.
- Whether herbicide use is necessary or whether cultural and physical methods of control will be sufficient for the required level of weed control in each situation.

If it is decided that herbicide use is necessary, the following factors are important when selecting a particular product:

- Is it approved for the intended use and situation?
- Will it control the weed species present or anticipated?

- How persistent is the control, will re-application be required?
- Is it damaging to the crop?
- Can it be safely prepared and applied with the available equipment?
- Can all usage restrictions be complied with?
- Does it pose the least risk to human health, the environment and other relevant creatures that may be sensitive to pesticides?

The main source of information to allow a user to use a pesticide safely and effectively is the product label. Information in this weed control guide may be used to select herbicides for programme planning purposes, but it is essential that the product label is read and understood before the product is used as it informs the user on safe and proper use and provides the basic information needed to do a COSHH assessment (see Appendix 2).

If it is deemed necessary to use a pesticide, health and safety considerations must be taken into account. Many pesticides are hazardous to health. COSHH requires a suitable assessment of the risks to health from the use of a pesticide before work starts.

Such assessments must include:

- Consideration of the hazards presented by the pesticide.
- Deciding who could be harmed and how.
- Identification of action to prevent exposure, or achieve adequate control of exposure, and to comply with COSHH requirements.
- Recording of the findings of the assessment when necessary.
- Revision of the assessment when required.

Detailed instruction on carrying out COSHH assessments are beyond the scope of this guide, further information can be found in the *Code of Practice for using Plant Protection Products*. Defra, PB11090, http://www.pesticides.gov.uk/Resources/CRD/Migrated-Resources/Documents/C/Code_of_Practice_for_using_Plant_Protection_Products_-_Complete20Code.pdf.

Further consideration should be given to protecting wildlife and the environment. Some details of these aspects are given in the Code of Practice referred to previously. Specific aspects are considered in more detail in *Protecting our Water, Soil and Air - A Code of Good Agricultural Practice for farmers, growers and land managers.* Defra, ISBN 978-0-11-243284-5, http://www.defra.gov.uk/publications/files/pb13558-cogap-090202.pdf.

Monitoring

Whilst a weed control plan may include provision for dealing with unexpected circumstances, regular monitoring is essential.

This might include checking:

- Nursery hygiene – is good practice being carried out.
- Presence of unexpected or resistant weeds.
- Crop damage.
- Factors that might affect herbicide efficacy e.g. weather or soil conditions.
- Factors that might affect crop tolerance to herbicides e.g. soft plant growth.

Regular monitoring enables prompt action to be taken, including the removal of any weeds about to set seed or altering the choice of herbicide applied.

Nursery hygiene

Even the most expensive and comprehensive herbicide programme will not work if the nursery is under extreme weed pressure. Take a critical look at the nursery to see if some of the sources of weeds can be eliminated to alleviate weed pressure.

Aspect	Action
Growing media ingredients	Keep heaps of peat and other ingredients covered to avoid contamination from wind-blown seeds. Some peats can be naturally infested with sorrel and rushes (buy from a reputable source).
Dirty pots and trays	If pots and trays are re-used always clean and sterilise them before use.
Irrigation water	Weed seeds can be spread via the water supply to the nursery. Cover tanks where practical. This will also prevent the build-up of algae and spread of mosses and liverwort. For large reservoirs, where it may be impractical to cover, ensure the banks are clear of flowering weeds, particularly near the abstraction point.
Cuttings	To prevent weed seeds contaminating cuttings, keep stock plant areas clear of weeds. Due to the risk of herbicide damage to stock plants, woven black plastic ground cover materials or a bark mulch can be used to control weeds.
Waste heaps	Do not keep waste heaps next to the container area. Cover heaps or regularly remove waste in skips.
Old stock	Try to avoid placing freshly potted stock in amongst old stock which may have a higher level of weed infestation. Before spring potting, gather old stock together in an area away from that intended for the new stock.
Standing beds	Clean beds as soon as each area is cleared. Although in many cases the application of herbicides over the crop will also give control between the pots, on many sites a specific herbicide treatment will be helpful.
Surrounding areas and paths	To prevent problems with wind-blown seed, such as willowherb, groundsel and sowthistle, keep adjoining fields mown or sprayed off. Windbreaks, fence lines, paths and areas between tunnels should be treated with herbicides. A number of products are cleared for use on pathways and non-cropped areas.

Non-chemical methods of weed control

Background

There is an increasing interest in non-chemical alternatives for weed control. Loose-fill mulches such as bark chips, grit and crushed nut shell are some products which along with pot-toppers now offer genuine potential to control weeds, moss and liverwort. They offer benefits in that only one application at potting is needed, no formal training or certification is required for their use, they are safe and pleasant to use and they can be used in herbicide sensitive crops where herbicide application may carry a high degree of risk.

Materials trialled

Mulches

Loose-fill mulches are more suitable for multi-branched or herbaceous subjects. A range of materials are available including bark chips, crushed nut shells, grit, waste wool pellets and potato cork flakes ('Biotop'). However, bark and cocoa shell mulches do tend to break down after a few months outdoors. They are better suited to short-term crops and plants in small pots such as liners, herbs, heathers or alpines where the use of a pot-topper is impractical. Spillage of loose-fill mulches when pots blow over, and removal of the mulch by foraging birds, can be a problem outdoors. Mulches can affect nitrogen availability. Bark and potato cork products can lock up nitrogen whereas waste wool products can give a 'flash' release of nitrogen.

Pot-toppers

A pot-topper may be defined as a covering material or mat which, when fitted around the base of the plant, forms a mulch over the growing medium surface. For best results and efficient handling, the pot-topper should be fitted when the plant is potted. However, pot-toppers are not suitable for multi-branched or herbaceous subjects where the cover can be difficult to fit and tends to become separated from the growing medium.

HDC project HNS 66 identified a number of materials with genuine potential to provide commercially acceptable levels of weed control. The best performing pot-toppers were those developed from coir, waste wool and jute. Each of these proved quick and easy to apply and provided weed control outdoors for a one year period following spring or summer potting.

Pot-toppers, typically made from coir or wool are now commercially available to fit a range of different pot sizes.

Practical guidelines

To be successful mulches and pot-toppers need to be:

- Permeable to water and non-phytotoxic.
- Light excluding to discourage weed growth.
- Stable and resistant to being removed or dislodged by wind and capable of sustaining weed control for up to 12 months.
- Easy to apply with the potential to combine with machine potting operations.
- Accurately cut and non-shrinking to achieve a good, precise fit.
- Cosmetically attractive at point of sale.
- Easily available and price competitive.

The future

The use of non-chemical weed control fits in well with the environmental policies of major retailers or suppliers to reduce chemical inputs. This can be an important selling point with some retailers and will result in these methods being adopted more widely.

For further information see the HDC Factsheet 25/12 '*Non-chemical weed control for container-grown hardy nursery stock*'.

Section 2: **The weeds**

Weeds of container nurseries

Weed biology

An understanding of the biology and life cycle of weeds will assist in better weed control management, whether cultural or chemical. It will also save labour and spray costs through better targeting of the weed control measures employed.

Many of the weeds found on container nurseries are rapid growing annuals, taking only a short time from germination to flowering. Flowering and germination periods can be seasonal, and such information is useful in planning hygiene and cultural control methods and in the timing of herbicide applications to ensure that most germination occurs well within the persistence period of the applied herbicide.

Flowering times are important as many weeds are prolific seeders and can spread rapidly through the nursery. A planned programme of hand weeding may be necessary if an important weed is coming into flower and seed dispersal is to be avoided. Knowledge of the source and seed distribution method of weeds is important in developing a hygiene programme for the nursery. Priority should be given to removing weeds dispersed by wind or exploding pods as these are likely to spread most rapidly.

When developing a weed control strategy it is important to first identify the range of weeds present on the nursery and consider which are the most important. This information is essential when drawing up an herbicide programme as most herbicides will only control a specific range of weeds. Over reliance on one herbicide can also lead to a build-up of resistant weeds.

Some weeds are easier than others to hand weed. Control of the difficult to weed subjects must be given priority whilst the weeds are small.

Weed profiles

This section includes a description of the key weeds that are often found on container-grown nursery stock along with their distribution on nurseries and their methods of dispersal.

Information is also given on the relative effectiveness of herbicides against each key weed. This information is largely drawn from the results of HDC projects HNS 35f, HNS 70 and HNS 139a. Some of the herbicides mentioned do not have label recommendations for use on nursery stock but may be used off-label either under an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) or via the Long Term Arrangements for Extension of Use (LTAEU). These are indicated as off-label approvals and may only have limited applications or uses. Further information on individual herbicides is given in Section 3.

Annual meadow-grass (*Poa annua* L.)

Characteristics

A low spreading annual grass, sometimes perennial, 5-30cm. Leaves hairless. Flower spikelets 3-10mm long, 3-10 flowers.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Frequently found in propagation units throughout the year and on outdoor crops over winter from autumn germination.

Seed dispersal

The seed can be spread via clothing, on cutting material, re-used pots and trays and from old stock.

General information

Difficult to hand weed once established in the container. Flexidor 125 does not control annual meadow-grass, so over reliance on Flexidor 125 in the herbicide programme (e.g. under protection) will lead to a build up of this weed.

Control measures

Cultural

- Remove weeds before they set seed.

Herbicides pre-emergence

- On-label: Devrinol, Ronstar 2G, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Aramo.

Bittercress, hairy (*Cardamine hirsuta* L.)

Characteristics

A short/medium hairy annual sometimes biennial, with a compact rosette of pinnate leaves. All leaflets are lobed or angled and sparsely hairy above and on the margins. It is variable in size depending on growing conditions. The flowers are small (3-4mm diameter), white and seed heads are formed on slender curved stalks.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

This is one of the most abundant weeds on container nurseries. It is widely distributed both in propagation and final production.

Seed dispersal

Seed is dispersed by means of 'exploding' seed pods. Although it can be spread on cutting material from stock plants, spread is particularly significant from seeding weeds in old stock. In severe cases the weed can spread onto standing beds to infest new stock.

General information

Although the individual weeds are often small and easy to pull out, the abundance and rapid spread of the seedlings makes this species a particular problem. Under dry conditions even very small plants have the ability to set seed. The increasing use of Flexidor 125 in herbicide programmes has reduced this particular weed because of it's effectiveness even on emerged seedlings.

Control measures

Cultural

- Remove weeds before they set seed.

Herbicides pre-emergence

- On-label: Flexidor 125, Ronstar 2G, Sultan 50 SC.
- Off-label: Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: Flexidor 125.
- Off-label: Sumimax, Venzar Flowable.

Bittercress, flexuous (*Cardamine flexuosa* With.) Bittercress, New Zealand (*Cardamine corymbosa*) Hook. f.

Characteristics

Low growing annuals, occasionally perennial, superficially similar to hairy bittercress (*C. hirsuta*).

Plant feature	Hairy bittercress *C. hirsuta*	Flexuous bittercress *C. flexuosa*	New Zealand bittercress *C. corymbosa*
Rosette	Tight and leafy	Open	Open, abundant prostrate stems
Stems	Hairy	Hairy	Few hairs
Stem leaves	1-4 per stem, hairy	5-11 per stem, hairy	0-4 per stem, few hairs
Leaflets per leaf	3-11, smooth outline	5-17, wavy outline	3-7, wavy outline
Flowers	4 stamens	6 stamens	6 stamens
Seed pods	Upright	Variable	Out-held

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■	■	■	■	■	■	

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■	■	■	■	■	■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Bittercresses are often the most abundant weeds on container nurseries. It is increasingly common to find mixed populations with all three species present.

Seed dispersal

Seed is dispersed by means of 'exploding' seed pods. Although it can be spread on cutting material from stock plants, spread is particularly significant from seeding weeds in old stock.

General information

Species identification is often difficult. Although many of the characteristics of the species are similar, both New Zealand and flexuous bittercress are thought to be more difficult to control by herbicides compared with hairy bittercress.

As a result populations of *C. corymbosa* and *C. flexuosa* are increasing relative to *C. hirsuta*.

Control measures

Cultural

- Remove weeds before they set seed.

Herbicides pre-emergence

- On-label: Flexidor 125, Ronstar 2G, Sultan 50 SC.
- Off-label: Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Sumimax.

Chickweed, common (*Stellaria media* (L.) Vill.)

Characteristics

A vigorous low spreading annual. Stems weak with a line of hairs. Leaves oval, bright green, the lower leaves are long-stalked. Flowers 8-10mm long, petals are white, cleft to base.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■					

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■	■				■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Fairly widely distributed on nurseries, both in propagation and final production.

Seed dispersal

The seed is slightly sticky and is spread on cutting material, re-used pots and trays and from old stock.

General information

Vigorous growth particularly in the autumn can readily choke young plants and affect quality. Ronstar 2G does not control common chickweed so over reliance on this herbicide will lead to a build up of this weed.

Control measures

Cultural

- Remove weeds before they set seed.

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Sumimax, Venzar Flowable.

Chickweed, mouse-ear (*Cerastium fontanum Baumg.* subsp. *triviale* (L.) Jalas)

Characteristics

A vigorous spreading low/short perennial, densely hairy with leafy non-flowering shoots. The leaves are dark green, lanceolate. The flowers are small often insignificant, white, deeply notched with lower bracts leaf-like, upper bracts sometimes white edged.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■	■	■	■	■	

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Fairly widely distributed on nurseries, particularly in final production. It can readily establish in gravel and sand beds.

Seed dispersal

The seed is slightly sticky and is spread on cutting material, re-used pots and trays and from old stock.

General information

The vigorous growth of this weed can readily choke young plants and affect quality. Over reliance on Ronstar 2G in the herbicide programme will lead to a build up of mouse-ear chickweed.

Control measures

Cultural

- Remove weeds before they set seed.

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Sumimax, Venzar Flowable.

Groundsel (*Senecio vulgaris* L.)

Characteristics

A short growing annual with erect succulent stems, slightly glabrous. The leaves are pinnately lobed either short-stalked or half clasping the stem. The flower heads are small, brush-like, yellow, in loose clusters. When mature the seed heads are fluffy and readily dispersed.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Very widely distributed on nurseries, both in propagation and final production.

Seed dispersal

Wind dispersal of the seed can spread the weed rapidly throughout the nursery. It is spread mainly from seeding weeds on old stock and bed edges but also on cutting material from stock plants. Even small plants can set seed under the right conditions.

General information

Although relatively easy to hand weed, the abundance of seed and subsequent seedlings makes groundsel a particular problem which has increased in recent years. Groundsel is susceptible to a rust which can spread to certain ornamental grasses.

Control measures

Cultural

- Remove weeds before seed is set.
- Control of the weed around bed edges is important.

Herbicides pre-emergence

- On-label: Devrinol, Ronstar 2G, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

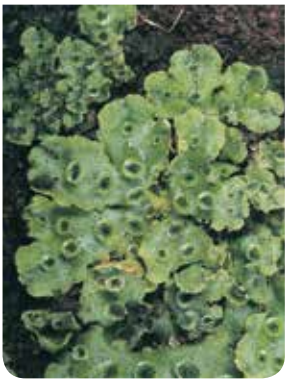
Herbicides post-emergence

- On-label: None.
- Off-label: None.

Liverwort (*Marchantia polymorpha* L.)

Characteristics

A bryophtye or lower plant, typically forming a thick slimy green layer over the growing media surface, from which surface stalked, umbrella-like, spore producing bodies can be seen when mature.



Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■						

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed on nurseries, particularly in propagation and protected production but also in final production. Over watering encourages liverwort development.

Seed dispersal

Liverwort can reproduce vegetatively from small fragments of tissue and gemmae and sexually via spores. Small lentil-shaped gemmae are produced in splash-cup structures on the liverwort surface. These gemmae are dispersed when water drops hit the structure. Yellow spores are produced in umbrella-like fruiting bodies that develop on short stalks from the main growth and are dispersed by wind or water when mature. Liverwort is frequently spread from gemmae and spore infestations on sand beds, pathways and old stock but can also be present on cutting material and in water films.

General information

Where severe infestation occurs in liners, surface root growth of the liner is suppressed, water can be prevented from reaching the substrate and weak plants can be smothered. The growth also provides shelter for shore and sciarid flies. Although less damaging on older stock, the appearance is unsightly and requires a great deal of hand cleaning to remove it at dispatch. Even the presence of dead liverwort following delayed treatment on plants can be unsightly requiring removal.

Control measures

Cultural

- Keep pot surfaces dry, for example, by the use of sand beds, avoidance of ‘wet’ irrigation regimes etc. Ensure plugs and liner growing media surfaces are cleaned free of liverwort before potting. The use of reduced-peat growing media reduces liverwort incidence substantially.

Herbicides pre-emergence

- On-label: Ronstar 2G (limited supression), Sultan 50 SC.
- Off-label: Venzar Flowable.

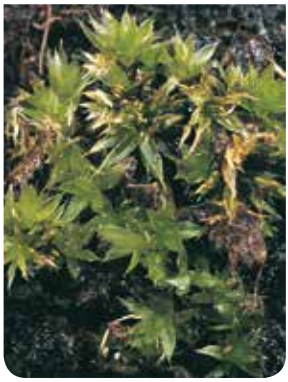
Herbicides post-emergence

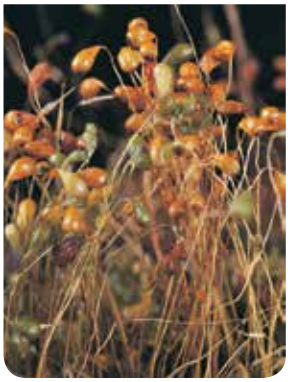
- On-label: None.
- Off-label: Venzar Flowable.

Moss (*Funaria hygrometrica* Hedw.)

Characteristics

A bryophtye or lower plant, typically starting as a thin hairy green film, later developing into a dense matted layer or mounded clumps over the growing media surface, from which small brown stalked spore producing bodies can be seen when mature.





Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■					

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Fairly widely distributed on nurseries, both in propagation and final production. It is particularly common on rooted cutting modules where these are held for an extended period before potting. It is also common on old stock or subjects that require a long growing period. Acidic growing media mixes are particularly prone to infestation.

Seed dispersal

The spores are wind and water spread on cutting material and from old stock.

General information

The presence on stock is unsightly giving the appearance of tired, old and pot bound material.

Control measures

Cultural

- Keep pot surface dry, for example, by the use of sand beds, avoidance of 'wet' irrigation regimes etc. Remove any infestation prior to potting modules.

Herbicides pre-emergence

- On-label: Ronstar 2G (limited supression).
- Off-label: Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Venzar Flowable.

Oxalis (*Oxalis* spp.)

Characteristics

A low creeping annual/perennial, stems rooting at leaf junctions. Leaves, brown, three-lobed, often closing up at night. Flowers small, yellow, five petalled, cup-shaped. Fruit is in the form of a capsule.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■							

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

It is an occasional problem on nurseries, notably under protection, often resulting from contaminated peat, but also spread from weeds growing in propagation houses, under benches and along bed edges. It is less common in final production except where infested peat is used.

Seed dispersal

Seed is spread from 'exploding' seed pods, but the weed is more commonly spread by stem or root fragments in the growing media.

General information

The vigorous growth can choke young plants and can be difficult to hand weed when established.

Control measures

Cultural

- Careful choice of peat supply.

Herbicides pre-emergence

- On-label: None.
- Off-label: None.

Herbicides post-emergence

- On-label: None.
- Off-label: None.

Pearlwort, common (*Sagina procumbens* L.)

Characteristics

Vigorous low growing perennial, spreading from non-flowering, star-like rosettes. Leaves, linear, ending in a minute bristle. Flowers, stalked, tiny, greenish white, petals are often absent. Where abundant, the growth forms a thick mat.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■			

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■	■	■	■	■	■	

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

A more recent problem on nurseries (often due to reliance on Ronstar 2G to which it is resistant), it is now widely distributed. Although it is particularly troublesome in final production it can also develop in newly potted stock. It is also frequently found in sand beds along path edges and growing through plastic ground cover. Seed from these sources spreads readily onto adjacent growing stock.

Seed dispersal

Prolific seed is set which readily sticks to clothing, cutting material, re-used pots and trays.

General information

Vigorous growth can readily choke young plants and affect quality. It is difficult to hand weed once well established in pots and can re-grow from root fragments left in pots or sand beds. Over reliance on Ronstar 2G in the herbicide programme will lead to a build up of this weed.

Control measures

Cultural

- Clean up standing beds and paths before setting down new pots.

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: None.

Sorrel (*Rumex* spp.)

Characteristics

Vigorous spreading low-perennial. Leaves, arrow-shaped. Flowers numerous brownish/white on long-stalked heads.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						■	■				

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■				■	■	■	

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

An occasional problem on nurseries due to contaminated peat, less frequent in recent years.

Seed dispersal

Although dispersal is possible by seed, the normal method of spread is by root or shoot fragments in contaminated peat.

General information

The weeds' vigorous growth can rapidly affect even large plants. It is easy to hand weed as a seedling, but once established in the pot it is impossible to remove by hand.

Control measures

Cultural

- Select an uncontaminated peat source.

Herbicides pre-emergence

- On-label: None.
- Off-label: None.

Herbicides post-emergence

- On-label: None.
- Off-label: None.

Sow-thistle, common (*Sonchus oleraceus* L.)

Characteristics

Medium greyish annual growing rapidly from tap-rooted rosettes. Leaves, hairless, clasping the stem and lobed with spiny margins. Flower heads are pale yellow thistle-like, 20-25 mm, forming fluffy seed heads when mature.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■	■	■	

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Occasional problem on nurseries where the weed has been allowed to set seed on perimeter areas and on old stock.

Seed dispersal

The seed is wind dispersed and can spread rapidly throughout the nursery.

General information

Although less abundant than groundsel these vigorous tap-rooted plants can be difficult to remove.

Control measures

Cultural

- Remove weeds before seed is set, control the weed around nursery perimeters.

Herbicides pre-emergence

- On-label: Devrinol, Ronstar 2G.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Sumimax.

Willow (*Salix caprea* L.)

Characteristics

Tree seedling. Leaves, oval with pointed tip, hairless above, downy grey beneath, youngest first leaves also reddish tinged.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■								

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■						

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

A more recent problem on some nurseries situated near to willow plantings and woodland. The fluffy seed can travel some distance. Newly potted stock is particularly vulnerable as the exposed growing media surface can provide suitable conditions for the seed to germinate.

Seed dispersal

Fluffy seed dispersed by wind.

General information

The weed seedlings can be numerous. Seedlings are relatively easy to remove when small, but impossible when larger. Once established they can even root down into the underlying standing bed. The herbicides normally used on nurseries will control this weed but only when recently applied, so where applications are infrequent it can become a particular problem.

Control measures

Cultural

- Use windbreaks to deflect seed. Where possible remove mature trees from around the nursery.

Herbicides pre-emergence

- On-label: Flexidor 125, Ronstar 2G, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: None.
- Off-label: Sumimax.

Willowherb (*Epilobium* spp.)

Characteristics

There are a number of different species, the most common are small/medium perennials. Leaves, alternate, lanceolate with small pale pink flowers maturing into fluffy seed heads. The abundant seedlings develop into glossy compact rosettes which overwinter before flowering. After senescence of the flower stem the basal rosette can re-grow.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■			

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■	■			■	■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed and increasing on nurseries, both in propagation and particularly outside in final production. It is frequently a problem on old stock. Path and polythene tunnel edges, waste and perimeter areas can often be infested with this weed particularly where ground is moist and other weeds have been controlled by herbicides.

Seed dispersal

Spread by wind dispersed seeds that are produced from the fluffy seed heads of mature plants.

General information

Willowherb can be a major problem on nurseries. It is relatively easy to hand weed, but the rapid and abundant germination of seedlings can be overwhelming leaving many small seedlings. A careful choice of herbicides is required for post-emergence control on beds and paths as some merely scorch the top growth leaving the basal rosette to re-grow.

Control measures

Cultural

- Remove weeds before they set seed. Control the weed around nursery perimeters, path edges and between tunnels.

Herbicides pre-emergence

- On-label: Devrinol, Ronstar 2G, Sultan 50 SC.
- Off-label: Dual Gold, Sumimax, Venzar Flowable.

Herbicide post-emergence

- On-label: None.
- Off-label: Sumimax, Venzar Flowable.

Section 3: **The herbicides**

Herbicides

It is important to understand the different types of herbicides available and their suitability for different uses.

The factors affecting the efficacy and safety of herbicides should always be considered before making herbicide applications.

The herbicide profiles contain reference information about individual products. This is intended to provide background information about the suitability of the product for a particular use, its likely safety and efficacy, and other information to be considered before use. It is not intended to provide all the information on the product label.

The product label must always be consulted before use.

Herbicide types

Herbicides can be classified according to their activity against weeds and also according to their selectivity to the crop.

Pre-weed emergence - residual, growing media acting

The majority of herbicides used in nursery stock production are residual. They are designed to be applied to a weed-free growing media surface and have a persistent effect preventing weeds from germinating or emerging. Ronstar 2G and Flexidor 125 are examples of this type of herbicide.

Most residual herbicides used in nursery stock are also crop tolerant, in that they can be applied over the foliage of some crops without causing damage. This selectivity will, however, depend on the crop species, *Buddleia*, for instance, is sensitive to a number of herbicides. The range of herbicides that can be used on herbaceous, alpines and heathers is more limited than the range used on shrubs and trees.

In some situations the time of year or crop growth stage is also important. Sumimax for example, can be damaging if applied to hardy nursery stock crops during the growing season. This is because of the sensitivity of new plant growth. However, it is less damaging when applied during the winter.

The crop tolerance of some sprays can be improved by wetting the foliage pre- and post-spraying. For granule herbicide applications, however, dry foliage is essential to avoid sticking and lodging in leaf axils.

Some residual herbicides are non-crop tolerant or total herbicides. These are only used in non-crop situations. Chikara Weed Control is a non-crop tolerant or total herbicide for use only on non-cropped areas such as pathways.

Contact and/or translocated – foliar acting

The foliar acting herbicides generally have a direct action on the weed foliage and can either be translocated, e.g. glyphosate, where the herbicide can travel through the plant from the sprayed leaves to affect the roots, or purely contact, e.g. diquat, where the herbicide only affects the parts sprayed. Most of these herbicides are also non-crop tolerant, that is they would damage crops if applied over them. Their use is restricted to controlling weeds on non-crop areas such as paths and perimeters, or on standing beds in the absence of a crop.

Some herbicides with contact activity are crop tolerant and can be used to control weeds already present within a crop. There are relatively few examples of this category used in container nursery stock production. An example is Aramo which can be used to control

grasses present within the crop. HDC projects HNS 35f, HNS 70 and HNS 139 have identified a number of herbicides such as Sumimax which have some potential for such use and further work is underway (HNS 139a) to establish the safety of the treatments on a wider range of nursery stock species.

A few residual soil acting herbicides also have useful post-emergence activity against certain seedling weeds. Often this is through root uptake, but sometimes also through a direct scorch to the foliage. Flexidor 125, for example, has activity against emerged hairy bittercress.

Pre or post-emergence

An alternative term often used is pre- or post-emergence. In agriculture this generally refers to the use of the herbicide either pre- or post-emergence of the crop. However in perennial crops such as nursery stock it is generally used in reference to the weed, e.g. use pre- or post-weed emergence.

Practical usage – factors affecting efficacy

Many soil or growing media acting herbicides do not work well under dry conditions. This is not normally a problem in overhead irrigated crops, but on sub-irrigated sand beds it may be necessary to irrigate after applying a herbicide. Some herbicides are also vulnerable to breakdown by light, including Devrinol and Flexidor 125, and should preferably be applied on a dull day and irrigated-in as soon as possible.

The water volume for spray application should be selected according to the label recommendation. At higher volumes it is easier to achieve good cover where there is a lot of crop or weed foliage.

The choice of a granule formulation or wet spray depends on the crop situation. Granular herbicides are often used as the first treatment after potting as these are more convenient when treating small areas. Batches of plants can therefore be treated as they are set down. For subsequent treatments either sprays or granules can be used. Granules may be less efficient if there is a full canopy of crop foliage, but may be preferred if small areas are to be treated. Over larger areas sprays may be preferable as they are easier and quicker to apply with suitable equipment.

The expected persistence of a residual herbicide should be noted so that a follow-up application can be planned before weeds start to germinate. In most cases, control is less efficient once weeds have been allowed to emerge. Conversely, top-up applications should not be made too soon because of the risk of crop damage from overdosing.

Growing media composition can have an influence on the crop selectivity and efficacy of residual herbicides. There is some evidence that peat-free mixes of coir and/or bark or wood based products may carry slightly more risk of herbicide damage and reduced residual life. Treatments should therefore be applied to a small area of the crop first to assess any adverse effects before the whole crop is treated.

Approval categories

On-label approval

Many herbicides listed in this guide are approved for use on nursery stock crops and have on-label recommendations for use. If label recommendations are followed precisely, then liability, for example, crop damage, will be covered by the marketing company. Use on a crop not listed on the label will not be covered by the marketing company in the case of any crop damage so it is advisable to test a small area first before treating the whole crop. This use will be at grower's own risk.

Off-label approval

Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product

Some herbicides have an off-label approval for use in ornamental plant production. The approval terminology has recently changed and Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) has replaced Specific Off-Label Approval (SOLA).

These are uses for which approval has been sought by individuals or organisations such as the HDC. Users of EAMUs must obtain a copy of the relevant Notice of Approval and comply strictly with the conditions. Any use of these products is entirely at the grower's own risk.

The Long Term Arrangements for Extension of Use

A further range of herbicides listed in this guide have no label approval or EAMU for use on nursery stock crops. Provided they are approved for use on a growing crop they may be used off-label under the Long Term Arrangements for Extension of Use (LTAEU) on ornamental crops such as nursery stock, subject to certain conditions. Any use of these products is entirely at the grower's own risk.

The Long Term Arrangements are gradually being withdrawn as products are re-registered and herbicides currently being used under these arrangements are being reviewed by the Chemicals Regulation Directorate (CRD). Where operator safety is considered acceptable, an EAMU is issued and the herbicide can continue to be used under the terms of the EAMU. If, following review, an EAMU is refused, the herbicide can no longer be used under the Long Term Arrangements.

Growers should acquaint themselves with developments and changes that are taking place with the Long Term Arrangements and be aware of any new EAMU for herbicides that become available to replace them. The best way to keep up to date is by using the link to the Liaison LTAEU database from the HDC website.

Table 1. Susceptibility of container nursery weeds to herbicides, pre-weed emergence

Weed \ Herbicide product	Dual Gold	Devrinol	Flexidor 125	Ronstar 2G	Sultan 50 SC	Sumimax	Venzar Flowable
Approval status	**EAMU**	**A**	**A**	**A**	**A**	**EAMU**	**LTAEU**
Annual meadow-grass		•		•	•		
Bittercress, hairy		•	•	•			
Canadian fleabane		•					
Charlock		•					
Chickweed, common		•	•		•		
Chickweed, mouse-ear							
Cleavers		•		•			
Dandelion							
Fat-hen		•		•			
Groundsel		•		•			
Knotgrass, common		•		•			
Liverwort		•		•			
Mayweed		•		•			
Mosses							
Nettle, small		•		•			
Oxalis				•			
Pansy, field		•					
Pearlwort			•				
Rushes							
Shepherd's purse		•	•	•	•		
Sorrel		•		•			
Sow-thistle, common		•		•			
Speedwell, common		•		•	•		
Willow							
Willowherb		•		•			

Susceptible	Moderately susceptible	Moderately resistant	Resistant

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

• Information derived from companies' own literature.

Herbicides with label recommendations

Herbicides with label recommendations for use in container-grown nursery stock

The following products have label recommendations for container-grown nursery stock. Information in this section is taken from the marketing company's label recommendations, except for the sections 'additional information' and 'experimental information' which are based on results of HDC trials and commercial practice.

These profiles are presented in alphabetical order of the typical product.

Other registered products with the same active ingredient as the typical products above are listed at the end of the section.

Always read the product label and use pesticides safely.

Devrinol

Active ingredient

Napropamide (450g/litre).

Formulation

Suspension concentrate.

Supplier

United Phosphorus Ltd.

Mode of action

Residual, soil or growing media acting, root absorbed.

Label recommendations

Container-grown trees and shrubs.

Rates of use

9.0 litres/ha (in up to 2,000 litres of water/ha).

Timing

November to end of April with 12mm irrigation after application.

Use under protection

No.

Label use restrictions

The growing medium should be firm around roots before application. Plants with poor vigour or shallow roots should not be treated. Liners or containers of less than one litre should not be treated.

Variegated and yellow and gold varieties of conifers and alpines should not be treated. Maximum of one treatment per crop or year.

Additional information

Effective against a wide range of weeds but not against hairy bittercress. The risk of photo-degradation limits the application of this herbicide to winter months. Persistence can be variable in container crops. A wide range of trees and shrubs has been treated and a limited range of herbaceous plants, apart from gold and yellow conifers and container-grown alpines, no phytotoxicity has been noted.

Experimental information

Devrinol was used in HDC trials on container-grown shrubs as part of HNS 35 and gave good results from an autumn/winter treatment when used in a programme with other herbicides. HDC project HNS 35e, on container-grown herbaceous crops, indicated that most crop species were not affected but that the lack of control of hairy bittercress was a limitation.

Flexidor 125

Active ingredient

Isoxaben (125g/litre).

Formulation

Suspension concentrate.

Supplier

Landseer.

Mode of action

Residual, soil or growing media acting, root absorbed.

Label recommendations

Container-grown hardy ornamental nursery stock.

Rates of use

2.0 litres/ha (in 600-1,000 litres of water/ha).

Timing

From at least 7-10 days after potting.

Use under protection

EAMU 0891/05.

Label use restrictions

Maximum of two applications per crop or per annum. Rainfall or irrigation (20-30mm) should be applied within three days of treatment (preferably sooner).

Additional information

Flexidor 125 gives good control of the important nursery stock weeds, chickweed, hairy bittercress and pearlwort. Control of annual meadow-grass, groundsel and willowherb is less effective and there is no control of liverwort and moss, so it is important to use in a programme with other herbicides. Persistence is good; in trials it has generally been used in 18 week programmes. Flexidor 125 has been used on a wide range of hardy nursery stock, but a few species can be damaged (notably *Buddleia* and *Cornus*) and others can have reduced growth (see Table 2). There is an EAMU for use under protection. This is useful as few herbicides are approved in this situation. However, such use is at grower's own risk.

Experimental information

In HDC trials a rate of 1 litre/ha in 2,500 litres of water/ha has normally been used and has given good general weed control. The label rate is however 2 litres/ha. The higher rate is necessary for some groundsel control, but even at the higher rate control is not reliable. Flexidor 125 has also been trialled on herbaceous plants and alpines and has potential for use on a limited range of these species (Tables 5 and 6). However such use is at grower's own risk.

Ronstar 2G

Active ingredient

Oxadiazon (2% w/w).

Formulation

Granule.

Supplier

Certis.

Mode of action

Residual.

Label recommendations

Container-grown nursery stock, including a wide range of ornamental shrub species.

Rates of use

200kg/ha.

Timing

As soon as possible after potting, plants may receive a second application 3-4 months later.

Use under protection

Can be used in protected structures when the plants are maintained under cool conditions and well ventilated. There are no recommendations for use under glass or in unventilated polythene tunnels.

Label use restrictions

Genista pilosa, Hydrangea and Spiraea should not be treated. Plants need to receive overhead watering or rainfall after treatment to ensure good weed control. Do not apply to plants with wet foliage or under conditions in which the granules will lodge or collect on leaves.

Additional information

Ronstar 2G is one of the most commonly used herbicides in container nursery stock production. One application after potting will give around 12 weeks weed control.

Ronstar 2G controls the main range of common nursery stock weeds and is particularly effective on willowherb. There is some preventative control of liverwort, but Ronstar 2G will not eradicate established liverwort. Unfortunately mouse-ear chickweed and pearlwort are resistant and these weeds tend to build-up if Ronstar 2G is used exclusively on a regular basis. Annual meadow-grass is sometimes not well controlled by Ronstar 2G. For these reasons alternative treatments should be used in a programme.

A major advantage is the relative safety of the product to hardy nursery stock. However, care should be taken to avoid the granules sticking to wet foliage. Uniform application can be a problem under full crop canopy.

Experimental information

Ronstar 2G has also been trialled on a range of herbaceous and alpine plants (HDC projects HNS 35e, HNS 74 and HNS 166). See Tables 5 and 6 for crop tolerances. Use on these crops is at grower's risk.

Herbicides without label recommendations

Herbicides without label recommendations

The information in this section is based on results of HDC trials and commercial practice. There are no label recommendations for the use of these products on container-grown nursery stock. However, usage on nursery stock crops is permitted off-label via an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) or under the Long Term Arrangements for Extension of Use (LTAEU) but any such usage by growers is entirely at their own risk.

These profiles are presented in alphabetical order of the typical product.

Other registered products with the same active ingredient as the typical products above are listed at the end of the section.

Always read the product label and use pesticides safely.

Dual Gold

Active ingredient

S-metolachlor (960g/litre).

Formulation

Suspension concentrate.

Supplier

Syngenta Crop Protection.

Mode of action

Selective, pre-emergence residual.

Approval status

EAMU 0501/12.

Rates of use

0.78 litres/ha (in 200-400 litres of water/ha).

Timing

1 May–31 May only.

Use under protection

No.

Label use restrictions

1 application per crop.

Additional information

Dual Gold is a pre-emergence residual herbicide with very little contact action on emerged weeds or crop. A good range of grasses including annual meadow-grass is controlled together with a more limited range of broad-leaved weeds. Some important weeds of container nursery stock are well controlled including chickweeds, pearlwort, sow-thistle and willowherb, however groundsel is only moderately controlled and bittercress is not well controlled. Its main use in nursery stock is likely to be as a short-term early summer herbicide particularly in programmes or mixtures with Flexidor 125 where improved control of grasses, groundsel and willowherb is required. Initial results indicate that liverwort and moss are controlled but further tests are required to confirm this. A similar formulation to Dual Gold has been available for several years in the US for use on container-grown nursery stock and crop safety information is included in Table 2. Note that the US label advises irrigation after application to avoid foliar damage.

Experimental information

Dual Gold was tested on a range of hardy nursery stock in HDC projects HNS 139 and HNS 139a as a summer treatment and was found to be safe on the majority of broad-leaved and evergreen shrub species tested. Results of the crop safety tests are shown in Table 2. Further trials were carried out to assess safety on a wide range of herbaceous subjects (HNS 166) and results were encouraging with only *Campanula, Delphinium, Echinacea, Leucanthemum, Monarda, Rudbeckia* and *Stachys* showing sensitivity.

Sultan 50 SC

Active ingredient

Metazachlor (500g/litre).

Formulation

Suspension concentrate.

Supplier

Makhteshim-Agan (UK) Ltd.

Mode of action

Residual, soil or growing media acting, some activity against emerged weeds.

Approval status

Approved for outdoor ornamental plant production.

Rates of use

0.66-1.5 litres/ha (in 220-450 litres of water/ha).

Timing

Autumn-winter when growth has hardened.

Use under protection

No.

Label use restrictions

Applications are limited to a total dose of not more than 2 litres/ha in a three year period on the same field. This is equivalent to 0.66 litres/ha per year. Do not apply to plants with soft vigorously growing foliage.

Additional information

Similar product, Butisan S, has been widely used on container-grown nursery stock although the label states that crops grown in containers should not be treated and this restriction should be adhered to now that the LTAEU have been restricted. The label for Sultan 50 SC does not contain this restriction although it does not specifically recommend use on container-grown nursery stock. Therefore use on container-grown nursery stock is made at growers' risk.

Experimental information

All experimental work was carried out with similar product Butisan S at a higher (2.5 litres/ha) rate in many HDC projects (HNS 28, HNS 28a. HNS 35, HNS 35a-g, HNS 70, HNS 74, HNS 93c, HNS 111 and HNS 139). Crop damage occured in some trials. At 2.5 litres/ha it was particularly effective against chickweed, grasses, groundsel, liverwort, pearlwort and willowherb but current lower rates may be less effective. Application to soft growth in spring and early summer were damaging. Application just prior to the onset of growth in early spring also caused problems on some species. Damage was enhanced by the addition of Flexidor 125 in a tank mix. However, in many cases the plants grew away with little effect by the end of the season. Damage was reduced by washing off after application.

Butisan S, when used in a programme with Flexidor 125, has generally given good weed control in HDC trials and has good persistence. When used as a tank mix with Flexidor 125 weed control was further enhanced, but the risk of damage was increased. There seems to be a reasonable margin of safety if application is made during autumn through to winter.

Sensitive plant species include *Buddleia, Cornus, Cotoneaster, Euonymus, Potentilla* and *Prunus.*

Sumimax

Active ingredient

Flumioxazine (300g/litre).

Formulation

Suspension concentrate.

Supplier

Interfarm (UK) Ltd.

Mode of action

Selective, pre-emergence residual with contact action.

Approval status

EAMU 2881/08.

Rates of use

0.1 litre/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on the label but due to strong contact action it is only likely to be safe on fully dormant crops.

Use under protection

No.

Label use restrictions

1 application per crop.

Additional information

Similar products Digital (EAMU 2844/08) and Guillotine (EAMU 2897/08) also have approval for use in ornamental plant production. Sumimax is a pre-emergence residual herbicide with strong contact action on emerged weeds via root uptake and foliar action. A good range of broad-leaved weeds are controlled but grasses are more resistant.

Some important weeds of container nursery stock are controlled including bittercress, chickweeds, groundsel, pearlwort, sow-thistle, willow and willowherb. As Sumimax has a strong contact action it will be damaging to broad-leaved deciduous crops when in leaf or to evergreens where the leaf is not sufficiently hardened. Use on container nursery stock will therefore be limited to the dormant season where it has potential as a winter clean up treatment. Products that are similar to Sumimax have been used in the US on nursery stock but normally only as winter treatments on established crops.

Experimental information

Sumimax was tested on a range of hardy nursery stock in HDC project HNS 139a as a winter treatment and was found to be safe to the broad-leaved and evergreen shrub species tested when dormant although *Buddleia, Escallonia* and *Vinca* were damaged. The use of Sumimax during the growing season was not investigated in HNS 139 because of the greater risk of damage.

Venzar Flowable

Active ingredient

Lenacil (440g/litre).

Formulation

Suspension concentrate.

Supplier

Du Pont Ltd.

Mode of action

Residual, soil or growing media acting.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

Up to 5.0 litres/ha (in 200 litres of water/ha) (lower rates have been used in trials with improved crop safety).

Timing

Autumn-winter.

Use under protection

No.

Label use restrictions

Up to four applications, one initially at up to 5 litres/ha followed by one at 1.3 litres/ha or three at 0.4 litres/ha.

Additional information

The superceded product Clayton Lenacil 80W carried a label recommendation for established roses and established woody ornamentals. Flowable formulations of lenacil listed at the end of the section can be used on nursery stock under the Long Term Arrangements for Extension of Use.

Experimental information

Lenacil has given good control of weeds in trials over the years and has been particularly effective against liverwort. However, the amount of damage has been unpredictable and unacceptable, particularly when used in the summer during periods of rapid growth.

Cistus and Santolina have been killed by summer applications and veinal yellowing has been caused on subjects such as *Ceanothus, Deutzia, Forsythia, Lavatera, Philadelphus, Potentilla, Pyracantha* and *Viburnum* (HDC project HNS 35a), and liners of *Ceanothus, Euonymus* and *Forsythia* (HNS 93, HNS 93c).

Autumn and winter applications appear less damaging although in western areas of high winter rainfall damage can still occur. Conifer species in trials have not been damaged.

A number of herbaceous subjects were treated without damage (HNS 35e and HNS 166), but as with hardy nursery stock, summer treatments tended to result in more damage. Although crop tolerance information is limited, it shows some potential for use as an autumn/winter herbicide on hardy nursery stock in drier areas and certain herbaceous crops.

HDC projects (HNS 93 and HNS 93c) have shown the potential for lenacil as a winter herbicide on mature liners for the control of liverwort and moss. However, there is no approval for the use of Venzar Flowable under protection.

Herbicides for non-cropped areas

Herbicides for use on non-cropped areas

The information in this section is based on results of HDC trials and commercial practice. Some products have label recommendations for non-cropped areas. There are no label recommendations for the use of these products in container-grown nursery stock production.

These profiles are presented in alphabetical order of the typical product.

Other registered products with the same active ingredient as the typical products above are listed at the end of the section.

Always read the product label and use pesticides safely.

Chikara Weed Control

Active ingredient

Flazasulfuron (25% w/w).

Formulation

Wettable powder.

Supplier

Belchim Crop Protection Ltd.

Mode of action

Non-selective, pre-emergence residual with contact action.

Label recommendations

Natural surfaces not intended to bear vegetation, permeable surfaces overlying soil.

Rates of use

0.15kg/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on the label.

Use under protection

No.

Label use restrictions

Non crop use only.

Additional information

Chikara Weed Control should only be used as a total herbicide on non-cropped areas such as paths and fence lines. It has a broad weed control spectrum and persistence of up to 6 months. It may also be used as a standing bed treatment (see below) although this use is not on the label recommendation. Chikara Weed Control should not be used as an overhead spray treatment on container-grown nursery stock as it is not approved for this use and will cause damage.

Experimental information

Chikara Weed Control has been tested in HDC project HNS 167 as a weed control treatment with incidental control of rooting through on sand beds used for container-grown hardy nursery stock and heathers. It was a very effective weed control treatment and also prevented rooting through in heathers and two vigorous test species, *Buddleia* and *Weigela*. No phyotoxicity was noted on plants stood down on the bed after sand bed treatment, although rooting was initially reduced at the bottom of the pot.

On the basis of this work, and following advice that such use is permitted within the product approval, Chikara Weed Control can be used as a weed control treatment on outdoor capillary sand beds before stocking with container plants. Such use however is entirely at the grower's own risk. Other container standing beds (such as gravel beds) have also been treated in commercial practice.

Container beds should be lightly raked, leveled and cleared of any debris/spilt growing media before Chikara Weed Control is applied.

Chikara Weed Control is not cleared for use under protection and on no account should it be sprayed over container plants otherwise damage will occur.

Finalsan Plus

Active ingredient

Pelargonic acid 186.7g/litre + maleic hydrazide 30g/litre.

Formulation

Soluble concentrate.

Supplier

Certis.

Mode of action

Non-selective contact.

Label recommendations

Ornamental plant production (around woody plants and trees). Amenity vegetation. Natural surfaces not intended to bear vegetation, permeable surfaces overlying soil.

Rates of use

166 litres/ha (in 1,000 litres of water/ha).

Timing

Apply during vegetation period.

Use under protection

No.

Label use restrictions

Do not direct spray or allow spray drift onto cultivated plants. A spray shield should be used for application in order to protect vulnerable foliage. Do not use Finalsan Plus against mosses or weeds in grass.

Additional information

Finalsan Plus is a herbicide with foliar activity against a broad range of weeds. Algae and mosses in open spaces around trees will usually be controlled by a single application. Good spray cover of the algae, mosses and weeds is essential. Finalsan Plus is most effective against small actively growing weeds. Weeds must be dry before application. Finalsan Plus does not have a long-term effect and re-emergence of affected weeds may occur. Therefore a repeat application may be required after 30-60 days. Algae and mosses in open spaces around trees will usually be controlled by a single application but repeat application may be applied after 30-60 days if incomplete control is achieved or following re-growth.

Harvest

Active ingredient

Glufosinate-ammonium 150g/litre.

Formulation

Soluble concentrate.

Supplier

Bayer CropScience Ltd.

Mode of action

Non-selective contact.

Label recommendations

Non-cropped areas.

Rates of use

5.0 litres/ha (in 200-550 litres of water/ha).

Timing

Apply between 1 March and 30 September when weeds are growing actively.

Use under protection

No.

Label use restrictions

Do not spray wet foliage or if rain likely within six hours.

Additional information

For control of emerged weeds in non-cropped areas apply as a directed spray avoiding any crop foliage. Slower acting than diquat formulations, but better control of small nettle and willowherb and more persistent control of perennial weeds is achieved. There is no residual action.

Reglone

Active ingredient

Diquat (200g/litre).

Formulation

Soluble concentrate.

Supplier

Syngenta Crop Protection UK Ltd.

Mode of action

Non-selective contact.

Label recommendations

Contact weed control pre-planting, in non-cropped areas and around crops.

Rates of use

2.0 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on the label.

Use under protection

Yes.

Label use restrictions

For use around crops or non-cropped areas.

Additional information

For control of emerged weeds in non-cropped areas when applied as a directed spray to avoid crop foliage. Most annual broad-leaved weeds are controlled when small, cleavers, grasses, knotgrass and small nettle become resistant beyond the seedling stage. The top growth of perennial weeds is controlled but re-growth will occur, as diquat is not translocated to the root system. More persistent results can be obtained by spraying under dull conditions.

Ronstar Liquid

Active ingredient

Oxadiazon (250g/litre).

Formulation

Emulsifiable concentrate.

Supplier

Certis.

Mode of action

Residual, soil or growing media acting, with contact action.

Label recommendations

Standing beds, field-grown ornamental trees and shrubs.

Rates of use

4.0-8.0 litres/ha (in 300-1,000 litres of water/ha).

Timing

Prior to standing down plants on beds.

Use under protection

No.

Label use restrictions

Avoid spraying young leaves or shoots. Pre-emergence activity is reduced where the soil organic matter content is more than 10%. Do not cultivate the soil after treatment.

Additional information

Ronstar Liquid should only be used as a standing bed treatment, it is not recommended as an overhead spray on container-grown nursery stock. It has a wide weed spectrum including cleavers, groundsel, knotgrass, and willowherb. Chickweed and pearlwort are not controlled. This can be a drawback when used as a standing bed treatment.

Experimental information

A mixture of Ronstar Liquid and Flexidor 125 performed well as a standing bed treatment prior to setting out hardy nursery stock in HDC project HNS 35d.

The use of Ronstar Liquid as a winter treatment over dormant container-grown shrubs was investigated in HDC project HNS 111 for one year only. Results were promising, even for some evergreens, but *Ceanothus*, *Choisya* and *Lavatera* were slightly damaged. As a winter treatment Ronstar Liquid has the potential to control larger groundsel and willowherb weeds than would be possible with other treatments, but only a limited number of shrubs have been tested with this treatment so far.

Roundup

Active ingredient

Glyphosate 360g/litre.

Formulation

Soluble concentrate.

Supplier

Monsanto (UK) Ltd.

Mode of action

Non selective, contact, translocated.

Label recommendations

Various including; hard surfaces, land not intended to bear vegetation, paths and drives.

Rates of use

Up to 5.0 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction but weeds should be actively growing.

Use under protection

No.

Label use restrictions

Varies according to product.

Additional information

Used for the control of annual and perennial weeds on paths and non-cropped areas. Must be used as a directed spray with great care. As the product is translocated, even a small amount of drift onto crop foliage can cause lasting damage.

Shark

Active ingredient

Carfentrazone-ethyl (60g/litre).

Formulation

Micro-emulsion.

Supplier

Bechim Crop Protection Ltd.

Mode of action

Non-selective contact.

Approval status

EAMU 2552/08.

Rates of use

0.33-0.8 litres/ha (in 200-400 litre of water/ha).

Timing

No restriction specified on EAMU.

Use under protection

Yes.

Label use restrictions

Maximum of 1.6 litres/ha of product per crop. A minimum spray interval of 7 days must be observed between applications. For use around crops or non-cropped areas.

Additional information

For control of emerged weeds in non-cropped areas or around crops when applied as a directed spray to avoid crop foliage. For use also at pre-planting. Most annual broad-leaved weeds are controlled when small, but chickweeds, grasses, groundsel and mayweed are not well controlled. The top growth of some perennial weeds can be scorched but re-growth will occur, as Shark is not translocated to the root system. A tank mixture with Harvest gives improved control of cleavers, cranesbill and willowherb.

Other registered products with the same active ingredient as the typical products

Herbicides with label recommendations

Typical product	Active ingredient
Devrinol	**Napropamide**
Other products registered	**Approval holder**
Associate	FMC Chemical Sprl
Banweed	United Phosphorous Ltd
Jouster	Agriguard Ltd
MAC Napropamide 450 SC	MAC-GmbH
Nappa	Chemsource Ltd
Naprop	Globachem NV

Typical product	Active ingredient
Flexidor 125	**Isoxaben**
Other products registered	**Approval holder**
Agriguard Isoxaben	Agriguard Ltd
Flexidor	Dow AgroSciences Ltd
Gallery 125	Rigby Taylor Ltd

Herbicides without label recommendations

Typical product	Active ingredient
Sultan 50 SC	**Metazachlor**
Other products registered	**Approval holder**
Agrotech Metazachlor 500 SC	Agrotech Trading GmbH
Alpha Metazachlor 50 SC	Makhteshim-Agan (UK) Ltd
Butey	Chem-Wise Ltd
Butisan S	Makhteshim-Agan (UK) Ltd
Clayton Buzz	Clayton Plant Protection (UK) Ltd
Clayton Metazachlor 50 SC	Clayton Plant Protection (UK) Ltd
EA Metazachlor	European Agrochemicals Ltd
Fuego 50	Makhteshim-Agan (UK) Ltd
Greencrop Monogram	Greencrop Technology Ltd
Makila 500 SC	Novastar Link Ltd

Typical product	Active ingredient
Marksman	AgriGuard Ltd
Mashona	AgChemAccess Ltd
Metachlor	Euro Chemicals s.r.o.
Metaz 50	RouteOne Products Ltd
Metazachlore GL 500	Globachem NV
Mezzanine	AgriGuard Ltd
Rhapsan 500 SC	Nufarm UK Ltd
Route One Metaz 50	Albaugh UK Ltd
Standon Metazachlor 500	Standon Chemicals Ltd

Typical product	Active ingredient
Sumimax	**Flumioxazine**
Other products registered	**Approval holder**
Digital	Interfarm (UK) Ltd
Guillotine	Interfarm (UK) Ltd

Typical product	Active ingredient
Venzar Flowable	**Lenacil**
Other products registered	**Approval holder**
Agriguard Lenacil	Tronsan Ltd
Fernpath Lenzo Flo	Agriguard Ltd
Lenazar Flo	Hermoo Belgium NV
Venzar 80 WP	Du Pont (UK) Ltd

Herbicides for non-cropped areas

Typical product	Active ingredient
Chikara Weed Control	**Flazasulfuron**
Other products registered	**Approval holder**
Chikara	Nomix Enviro Ltd
Chikita	ChemSource Ltd
Clayton Apt	Clayton Plant Protection (UK) Ltd
Paradise	Pan Agriculture Ltd
Pure Flazasul	Pure Amenity Ltd

Typical product	Active ingredient
Harvest	**Glufosinate-ammonium**
Other products registered	**Approval holder**
Basta	Bayer CropScience Ltd
Challenge	Bayer CropScience Ltd
Challenge 60	Bayer CropScience Ltd
Finale	Bayer Environmental Science
Finale 150	Bayer Environmental Science
Kaspar	Certis
Kibosh	AgChemAccess Ltd
KurTail	Progreen Weed Control Solutions Ltd
PureReep	Pure Amenity Ltd
Weedex	Novastar Link Ltd

Typical product	Active ingredient
Reglone	**Diquat**
Other products registered	**Approval holder**
Various	Various

Typical product	Active ingredient
Ronstar Liquid	**Oxadiazon**
Other products registered	**Approval holder**
Clayton Oxen FL	Clayton Plant Protection (UK) Ltd
Festival	Bayer Environmental Science
Noble Oxadiazon	Barclay Chemicals (R&D) Ltd
Standon Roxx L	Standon Chemicals Ltd

Typical product	Active ingredient
Roundup	**Glyphosate**
Other products registered	**Approval holder**
Various	Various

The addresses and contact details for the suppliers listed in this section can be found in Appendix 6.

Section 4: **Specific crop guidelines**

Specific crop guidelines

Trees, shrubs, conifers and climbers grown outside

Container crops grown outside can be subject to considerable weed pressure. However, there is a good range of herbicides available and, when used in conjunction with good cultural practice and a planned approach, it should be possible to achieve an economic level of weed control.

Nursery hygiene

No herbicide programme will work without there being good hygiene measures on the nursery to reduce the spread of weeds. Cultural measures of particular importance include:

- Removal of weeds from liners when potting up.
- Rigorous control of weeds on standing beds, paths and other non-cropped areas.
- Prompt removal of waste from the nursery.
- Segregation of old stock away from newly potted plants.
- Targeting hand weeding to ensure weeds are removed prior to seeding.

Herbicide options

The HDC has commissioned a number of projects on outdoor container-grown hardy nursery stock (HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35d, HNS 35f, HNS 93c, HNS 111, HNS 139 and HNS 139a) to examine the effectiveness and safety of many of the herbicides listed below.

Devrinol (napropamide)

Only used as a winter treatment because of rapid break down under high light conditions. The control of groundsel and willowherb is useful, but hairy bittercress is not controlled. There is good crop tolerance except on variegated, silver and gold cultivars.

Dual Gold (s-metolachlor)

An early summer herbicide treatment to use with Flexidor 125 to improve control of grasses, groundsel and willowherb. The use of Dual Gold on container-grown nursery stock is off-label under an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) and at grower's own risk.

Flexidor 125 (isoxaben)

Often used as a follow-up treatment to continue weed control after initial Ronstar 2G granule treatments have lost persistence. The control of bittercress, chickweed and pearlwort is good. A number of crop species are sensitive to isoxaben (see Table 2).

Ronstar 2G (oxadiazon)

Normally used straight after potting, before the foliage canopy covers the growing medium surface. Minimum phytotoxicity to hardy nursery stock has been noted, the main exclusions being *Genista pilosa*, *Hydrangea* and *Spiraea*. Care should be taken to ensure granules do not lodge in the foliage.

Sumimax (flumioxazine)

A winter treatment for general weed control with good contact activity. The use of Sumimax on container-grown nursery stock is off-label under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) and at grower's own risk.

Venzar Flowable (lenacil)

Sometimes used in the autumn or winter for liverwort and general weed control. Damage can occur under conditions of rapid crop growth so summer use is to be avoided. A number of crop species are sensitive to lenacil (see Table 2). The use of Venzar Flowable on container-grown nursery stock is off-label under the Long Term Arrangements for Extension of Use and at grower's own risk.

Programme guidelines

After potting

The herbicide programme should start as soon as possible after potting. Most growers find a granule more convenient to use at this stage, especially where there may be batches of plants to be treated in sequence. Ronstar 2G can be used immediately after potting and can be applied at the end of the potting line if necessary. Ronstar 2G gives control of a good spectrum of weeds, and persists for around 12 weeks, but gives poor control of chickweed and pearlwort.

Follow-up treatments

If Ronstar 2G is used after potting it could be followed within 12 weeks with a spray application of Flexidor 125 to extend the general weed control and prevent chickweed and pearlwort from establishing. Where groundsel and willowherb are a problem, Dual Gold could be used as a treatment in addition during May. Note that a number of species, including climbers, are sensitive to the isoxaben in Flexidor 125 and there is limited crop susceptibility data for Dual Gold (see Table 2.

Autumn–winter treatments

Following a summer application of Flexidor 125, trials work has indicated the potential of numerous herbicide options for use from autumn to winter including Devrinol, Ronstar 2G, Sumimax and Venzar Flowable as well as further applications of Flexidor 125 (see HNS 28, HNS 28a, HNS 35, HNS 35a HNS 139 and HNS 139a). It should be noted that these uses of Sumimax and Venzar Flowable are off-label and at grower's own risk.

If groundsel and willowherb are particular problems, then the use of Sumimax could be considered on a selected range of species once crops are fully dormant. Previously, the inclusion of Butisan S or Sultan 50 SC in the programme had generally given good results for weed control but recent label restrictions limit their use on container crops with Butisan S ruled out completely.

Venzar Flowable is sometimes used for liverwort and general weed control. In areas of heavy winter rainfall, however, damage can occur from root uptake, although conifers appear less likely to be damaged (HNS 35d).

A further top-up treatment of Flexidor 125 can also be made over winter, giving long-term control of hairy bittercress and other weeds into the spring.

During the winter, leaf fall on deciduous subjects makes the use of granules such as Ronstar 2G easier. This treatment is particularly suitable where groundsel and willowherb are a problem, rather than chickweed and pearlwort which are not controlled. Note that there is a limit of two applications of Ronstar 2G per crop.

Devrinol can also be used over winter for a range of weeds including chickweeds, groundsel, pearlwort, and willowherb. However, since it does not control hairy bittercress it is best used in a programme with Flexidor 125.

Table 2. Tolerance of container-grown trees, shrubs and climbers to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [4]	Sultan 50 SC [5]	Sumimax [6]	Venzar Flowable [7]
Approval status	**A**	**EAMU**	**A**	**A**	**A**	**EAMU**	**LTAEU**
Abelia				•			
Abutilon			•				
Acer			•	•			
Actinidia			•				
Alnus			•				
Amelanchier							
Amorpha			•	•			
Aralia							
Aucuba							
Azalea				•			
Berberis			•	•			
Betula			•				
Buddleia				•			
Buxus				•			
Callicarpa							
Camellia				•			
Campsis			•				
Caragana			•				
Carpinus			•				
Caryopteris							
Cassia			•				
Ceanothus				•			
Ceratostigmata							
Chaenomeles							
Choisya				•			
Cistus							
Clematis							
Colutea			•				
Cornus				•			
Corylus			•				
Cotinus							
Cotoneaster				•			
Crataegus			•				
Cytisus							
Daphne				•			
Deutzia			•	•			
Elaeagnus				•			
Escallonia			•	•			
Euonymus				•			
Exochorda							
Fagus			•	•			
Forsythia			•	•			
Fraxinus			•	•			
Fuchsia							
Garrya				•			
Genista				•			
Gleditsia			•				

Table 2. Tolerance of container-grown trees, shrubs and climbers to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [4]	Sultan 50 SC [5]	Sumimax [6]	Venzar Flowable [7]
Approval status	**A**	**EAMU**	**A**	**A**	**A**	**EAMU**	**LTAEU**
Hebe			•	•			
Hedera				•			
Helichrysum							
Hibiscus			•				
Hydrangea							
Hypericum			•	•			
Ilex				•			
Jasminum							
Kerria							
Kolkwitzia							
Laburnum			•				
Laurus				•			
Lavandula							
Lavatera							
Leucothoe							
Leycesteria							
Ligustrum			•	•			
Lonicera				•			
Magnolia				•			
Mahonia				•			
Myrtus				•			
Nandina				•			
Olearia				•			
Osmanthus							
Pachysandra				•			
Parthenocissus							
Perovskia							
Philadelphus			•	•			
Photinia							
Physocarpus							
Pieris				•			
Pittosporum				•			
Potentilla			•	•			
Prunus			•	•			
Pyracantha							
Quercus			•				
Rhododendron				•			
Rhus							
Ribes			•				
Robinia			•				
Rosa			•	•			
Rosmarinus							
Rubus				•			
Salix			•				
Sambucus							
Santolina							

Table 2. Tolerance of container-grown trees, shrubs and climbers to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [4]	Sultan 50 SC [5]	Sumimax [6]	Venzar Flowable [7]
Approval status	**A**	**EAMU**	**A**	**A**	**A**	**EAMU**	**LTAEU**
Sarcococca				•			
Senecio				•			
Skimmia			•	•			
Solanum							
Sophora			•				
Sorbaria							
Sorbus				•			
Spartium							
Spiraea			•				
Symphoricarpos							
Syringa							
Tamarix			•	•			
Tilia			•				
Viburnum				•			
Vinca				•			
Weigela			•	•			
Wisteria							
Yucca				•			

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use)

• Information derived from companies' own literature.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials prior to full scale treatment.

Information sources

1. Former label for Fisons Banweed.
2. HDC projects HNS 139, HNS 139a, label for Pennant Magnum (US).
3. Flexidor 125 label, HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f.
4. Ronstar 2G label, HDC projects HNS 28a, HNS 35a.
5. HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f.
6. HDC project HNS 139.
7. HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f (results using Venzar 80 WP).

Table 3. Tolerance of container-grown conifers to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [4]	Sultan 50 SC [5]	Sumimax [6]	Venzar Flowable [7]
Approval status	**A**	**EAMU**	**A**	**A**	**A**	**EAMU**	**LTAEU**
Abies							
Cedrus			•				
Chamaecyparis			•	•			
Cryptomeria							
X Cupressocyparis			•	•			
Cupressus				•			
Juniperus			•	•			
Picea				•			
Pinus			•	•			
Pseudotsuga			•				
Taxus				•			
Thuja			•	•			
Tsuga			•	•			

Tolerant	Crop damage does not normally occur.

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

• Information derived from companies' own literature.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small trials on plants prior to full scale treatment.

Information sources

1. Former label for Fisons Banweed.
2. HDC projects HNS 139, HNS 139a, label for Pennant Magnum (US).
3. Flexidor 125 label, HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f.
4. Ronstar 2G label, HDC projects HNS 28a, HNS 35a.
5. HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f.
6. HDC project HNS 139.
7. HDC projects HNS 28, HNS 28a, HNS 35, HNS 35a, HNS 35b, HNS 35f (results using Venzar 80 WP).

Propagation and plants grown on under protection

Young plants with limited root systems tend to be more vulnerable to herbicide damage or growth suppression. There are relatively few herbicides that are safe for use on weaned cuttings, liners and general use under protection. In addition, some herbicides that might be safe to crops cannot be used because there is no clearance for use under protection.

Nursery hygiene

Hygiene is particularly important. Indeed it could be argued that with good practice there should be no need to use herbicides at all in propagation. Cultural measures of particular relevance to protected crops include:

- Ensuring weeds are well controlled in stock beds by the use of mulches.
- Using only weed-free batches where cuttings are taken from growing crops.
- Using only clean pots and trays.
- Removal of weeds or moss from modules when potting up.
- Rigorous control of weeds on standing beds and paths.
- Avoiding overwatering which encourages liverwort and algal development.
- Targeting hand weeding to ensure weeds are removed prior to seeding.
- Covering water tanks.

Herbicide options

At present the only approved herbicides are Flexidor 125 and Ronstar 2G. A number of HDC projects (HNS 35b, HNS 35g, HNS 93 and HNS 93c) have been carried out in order to provide better information on herbicides for use under protection. These have indicated the potential for some herbicides that are not currently permitted for use under protection.

The trials have also provided useful information about the relative safety of the two approved herbicides Flexidor 125 and Ronstar 2G.

Flexidor 125 (isoxaben)

Use under protection is permitted under an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) at grower's own risk. A number of crop species are sensitive to isoxaben and may be particularly vulnerable in plug trays where the rooting volume is restricted (see Table 4).

Ronstar 2G (oxadiazon)

Label recommendation only covers use under cool conditions in well ventilated polythene structures. Use in glasshouses is not permitted. Care should be taken to ensure granules do not lodge in the foliage.

Programme guidelines

At the former HRI Efford, in HDC project HNS 35b, *Azalea* liners were found to be sensitive to Ronstar 2G and *Lavandula* suffered a slight check to growth from Flexidor 125. Further trial work continued on plug trays and liners under protection (HNS 35g) with a wide range of species and treatments, including Flexidor 125 (at a reduced 1 litre/ha rate) and Ronstar 2G.

Ronstar 2G caused least damage to liners and weaned cuttings in plug trays with very little damage reported. Some species suffered reduced or delayed spring growth from Flexidor 125 in some of the experimental treatments. This was more of a problem with plug trays, where the rooting volume was restricted, than on liners. Details are summarised in Table 4.

With the currently approved herbicides, an alternating programme of Ronstar 2G followed by Flexidor 125 followed by Ronstar 2G in winter should give the best results. However, the control of liverwort and moss may not always be adequate.

Results from HNS 93, HNS 93c and HNS 126 showed that adopting a 'drier' watering regime or use of peat-reduced growing media was effective in achieving control of moss and liverwort. Similarly the use of a growing media incorporating 30% wood fibre such as Silvafibre™ was found to substantially reduce the incidence of liverwort making chemical control much easier (HNS 93c and HNS 175 and work still continues investigating growing media amendments with glucosinolate rich seed meal).

HNS 93 and HNS 93c showed that Venzar Flowable has potential for use as a winter treatment for liverwort and moss control, but as yet there is no approval for use under protection.

Table 4. Tolerance of liners and weaned cuttings in plug trays under protection to herbicides

Crop \ Herbicide product	Flexidor 125	Ronstar 2G
Approval status	**EAMU**	**A**
Anisodontea		
Berberis		
Buddleia		
Ceanothus		
Chaenomeles		
Choisya		
Cistus		
Clematis		
Cornus		
Cotoneaster		
Cytisus		
Escallonia		
Euonymus	*	
Forsythia		
Hebe		
Hedera		
Hypericum		
Jasminum	*	
Kerria		
Lavatera		
Lavandula		
Ligustrum		
Lonicera		
Osmanthus		
Parthenocissus		
Polygonum		
Potentilla		
Pyracantha		
Rosmarinus		
Santolina		
Senecio		
Spiraea		**
Viburnum		
Vinca		
Weigela		

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

* Some cultivars have shown susceptibility.

** No damage recorded in these trials, however occasional damage is known to occur and no label recommendation is made for *Spiraea.*

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials prior to full scale treatment.

Information source

HDC project HNS 35g – herbicides applied to rooted cuttings during weaning and immediately after potting rooted cuttings from plug trays into liners.

For some species only one year's trials results were available to provide information for this table. It is still possible that species listed opposite as tolerant, could be damaged in different growing seasons.

Herbaceous plants

It is difficult to find an effective treatment that is safe to use over a wide range of species. There are no herbicides with label recommendations for use on container-grown herbaceous crops. However, while most herbicides cause at least some suppression of growth, this can still be acceptable compared to the cost and time of hand weeding. There are a number of genera such as Papaver and *Physostegia* that are very sensitive to any herbicide.

Nursery hygiene

Many growers of short-term herbaceous crops find that they can avoid herbicide use altogether, providing they adopt good hygiene measures to control the spread of weeds on the nursery. For some herbicide sensitive species the use of loose-fill pot mulches, such as bark, may be an effective alternative to herbicides. Good hygiene measures of particular relevance to herbaceous production include:

- Ensuring weeds are well controlled in stock beds by the use of mulches.
- Using only weed-free batches if cuttings are taken from growing crops.
- Using only clean pots and trays.
- Removal of weeds or moss from modules when potting up.
- Rigorous control of weeds on standing beds, paths and other non-cropped areas.
- Prompt removal of waste from the nursery.
- Segregation of old stock away from newly potted plants.
- Targeting hand weeding to ensure weeds are removed prior to seeding.

Herbicide options

HDC project HNS 35e showed that many species can be treated with Flexidor 125, Ronstar 2G or Venzar Flowable. As a result of variable crop sensitivity it is important to check crop tolerance lists before planning treatments (see Table 5).

Dual Gold (s-metolachlor)

An early summer herbicide treatment to use alone or in sequence with Flexidor 125 to improve control of grasses, groundsel and willowherb. Initial indications are that this herbicide is safe to use on a selected range of herbaceous subjects (see Table 5).

Flexidor 125 (isoxaben)

Often used as a follow-up treatment to continue weed control after initial Ronstar 2G granule treatments have lost persistence, although this may not always be necessary where herbaceous crops have formed a dense canopy. The control of chickweed, hairy bittercress and pearlwort is good. A number of crop species are sensitive to isoxaben (see Table 5).

Ronstar 2G (oxadiazon)

Normally used straight after potting, before the foliage canopy covers the gowing medium surface. Minimum damage to herbaceous crops has been noted providing subjects likely to accumulate granules in their rosettes are avoided. A sensible precaution would be to avoid applications to overwintered pots just prior to shoot emergence in the spring.

Venzar Flowable (lenacil)

Lenacil has also been tested in trials and has given good control of weeds, being particularly effective against hairy bittercress and liverwort. However, some damage can be caused particularly when used in the summer during periods of rapid growth. Autumn and winter applications appear less harmful but damage can still occur in western areas with heavy winter rainfall. A number of crop species are sensitive to lenacil (see Table 2).

The use of all of these herbicides on container-grown herbaceous nursery stock is permitted as these herbicides have either approval for ornamental plant production (Flexidor 125 and Ronstar 2G), off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) (Dual Gold), or can be used under the Long Term Arrangements for Extension of Use (Venzar Flowable), however none have specific label recommendations for use on herbaceous plants therefore such use is at grower's own risk.

Programme guidelines

After potting, a granular herbicide is often very convenient to use. Ronstar 2G can be applied to the species listed as tolerant (Table 5), although any lodged granules should be removed from the foliage by brushing or by using a blower.

Flexidor 125 can be used as a follow-up treatment to Ronstar 2G after 12 weeks or as an alternative. Many species will tolerate one application at 1 litre/ha (see Table 5), but repeat applications can have a cumulative effect that will affect growth. Venzar Flowable or Dual Gold are possible alternatives for species which are sensitive to Flexidor 125. However, applications of Venzar Flowable should not be made to any species during hot weather or periods of rapid growth.

There are few treatments available to control emerged weeds during the growing season. However, Reglone or Shark may be applied over a range of herbaceous plants during the dormant season, providing all foliage has died down. Species vary in response to this treatment and care has to be taken, especially in the south-west, where for many plants the dormant stage is very short.

Table 5. Tolerance of container-grown herbaceous plants to herbicides

Herbicide product / Crop	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [3]	Venzar Flowable [3]
Approval status	**A**	**EAMU**	**A**	**A**	**LTAEU**
Acanthus					
Achillea					
Agapanthus					
Ageratum					
Ajuga			*		
Alchemilla					
Alstroemeria					
Althaea					
Anemone					
Anthemis					
Aquilegia					
Arenaria					
Artemesia					
Aruncus					
Aster				*	
Astilbe			*		**
Astrantia					
Athyrium					
Bergenia					
Brunnera					
Campanula		**	**•	**	**
Carex					
Centaurea					
Centranthus					
Coreopsis					
Crambe					
Crocosmia				*	
Dahlia					
Delphinium	**				
Dianthus					
Diascia					
Dicentra					
Dierama					
Digitalis					
Dryopteris				**	
Echinacea					
Erigeron					
Eryngium					
Erysimum					
Euphorbia					

Table 5. Tolerance of container-grown herbaceous plants to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [3]	Venzar Flowable [3]
Approval status	**A**	**EAMU**	**A**	**A**	**LTAEU**
Fragaria					
Gaillardia					
Gaura					
Geranium					
Geum					
Hakonechola					
Helenium					
Helleborus					
Hemerocallis					
Heuchera					
Hosta				*	
Iberis					
Iris					
Kniphofia					
Lamium					
Leucanthemum					
Leymus					
Ligularia					
Lilium					
Liriope					
Lobelia					
Lupinus					
Lychnis					
Matteuccia					
Millium					
Miscanthus					
Monarda				*	
Nepeta					
Oenothera				**	**
Ophiopogon					
Origanum					
Pachysandra					
Papaver				**	**
Penstemon					**
Paeonia					
Phlox		*	**	*	
Physostegia					
Polygonum					
Polypodium					
Polystichum					
Potentilla					

Table 5. Tolerance of container-grown herbaceous plants to herbicides

Crop \ Herbicide product	Devrinol [1]	Dual Gold [2]	Flexidor 125 [3]	Ronstar 2G [3]	Venzar Flowable [3]
Approval status	**A**	**EAMU**	**A**	**A**	**LTAEU**
Primula					
Pulmonaria			*		
Pulsatilla					
Rhodohypoxis					
Rudbeckia			*		
Salvia					
Schizostylis				*	
Sedum	**		**		
Sidalcea					
Silene					
Sisyrinchium					
Solidago					
Stachys					
Symphytum					
Teucrium					
Tradescantia		**			
Verbena					
Veronica			**	**	**
Zantedeschia					

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Approved for ornamental plant production but no label recommendation for herbaceous crops, therefore use is off-label and at grower's own risk.

EAMU Off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

* Some cultivars have shown moderate susceptibility.

** Some cultivars have shown susceptibility.

• Information derived from companies' own literature.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials prior to full scale treatment.

Information sources

1. HDC project HNS 35e, HNS 166.
2. HDC projects HNS 139, HNS 166, label for Pennant Magnum.
3. HDC project HNS 35e, HNS 111, HNS 166.

These results refer to the following rates of use in HNS 35e:

Product	Product rate
Flexidor 125	1 litre/ha
Lenacil	1.7kg/ha
Ronstar 2G	200kg/ha

Herbs

Since container-grown herbs are classed as an edible crop, the normal range of herbicides approved for ornamental nursery stock cannot be used. However, there are a number of herbicides that have off-label approval for use on herbs, and that could be used on container-grown crops at the grower's own risk, including Kerb Flo and Venzar Flowable.

Nursery hygiene

In many cases, herbs are grown as a short term crop and it may be possible to avoid the use of herbicides altogether by ensuring good crop hygiene measures are undertaken on the nursery. These should include using clean pots free from weed seed, reducing background weed pressure in non-crop areas such as roads, headlands, pathways and container beds, as well as ensuring compost heaps and water storage tanks are kept covered to prevent weed seed contamination. Bought in plants, especially plugs and liners, can often be a source of weed problems and these should be hand weeded before potting on.

Given the difficulties of chemical weed control in herbs and their sensitivity to herbicides, non-chemical options should also be considered and can be used for liners, finished plants and stock plants. Loose-fill mulches such as bark chips, cocoa shell or grit are safe to the crops and can work well, particularly for short-term herb crops. Mulches also combine well with multi-branched plants, are decorative, add value, and can provide good suppression of liverwort and moss. Pot-toppers made from coir, wool or jute may also have a role, particularly for plants in larger two and three litre pots.

Alpines

Alpine crops present growers with a number of unique problems in respect of weed control. They are invariably grown in small pots which are difficult to hand weed efficiently and the wide range of varieties now in production complicates crop safety considerations. The small pot sizes also create additional hazards as many residual herbicides act as root inhibitors. Overhead irrigation which encourages the development of weeds, liverwort and moss is also widely used.

Nursery hygiene

For short term alpine crops it may be possible to avoid herbicide use altogether providing there are good hygiene measures to control the spread of weeds on the nursery. The use of loose-fill pot mulches, such as grit, may be an effective alternative. Good hygiene measures of particular relevance to alpine production include:

- Ensuring weeds are well controlled in stock beds by the use of mulches.
- Using only weed-free batches if cuttings are taken from growing crops.
- Use only clean pots and trays.
- Removal of weeds or moss from modules when potting up.
- Rigorous control of weeds on standing beds, paths and other non-cropped areas.
- Prompt removal of waste from the nursery.
- Segregating old stock away from newly potted stock.
- Targeting hand weeding to ensure weeds are removed prior to seeding.

Herbicide options

Weed control in the slower growing varieties that are overwintered can be a serious problem and it is here that the careful application of residual herbicides has the greatest commercial benefit. HDC projects HNS 35b and HNS 74, and commercial experience have identified a number of residual herbicides capable of providing acceptable levels of weed control in alpine crops. However, alpines can be very sensitive to the application of herbicides, particularly under protection where crop growth is softer. None of the herbicides currently used in nursery stock production carry specific label recommendations for treating alpines. Application therefore is done entirely at the grower's own risk. A small area should be treated first to assess any damage to the crop before treating the whole crop.

Flexidor 125 (isoxaben)

Has potential but can reduce vigour and delay flowering in some varieties, most notably *Veronica*. Combine in a programme for best results. Check crop tolerance carefully. *Campanula, Dianthus* and *Thymus* have shown sensitivity to Flexidor 125. Flowering in *Sedum* and *Thymus* may also be checked.

Ronstar 2G (oxadiazon)

Best applied straight after potting, before foliage canopy covers the growing media surface. Does not appear to cause damage to alpines, but lodged granules must be brushed or lightly rinsed off crop foliage otherwise damage can occur. *Campanula, Helianthemum, Phlox, Sedum* and *Thymus* showed sensitivity in HNS 74. Mossy saxifrages can also be sensitive to granules lodged in rosettes.

Venzar Flowable

Success and crop safety depends on rate and timing. Reduced rates can give excellent liverwort control but poor weed control unless tank mixed with other herbicides. Rates of 2.7 to 5 l/ha, whilst providing excellent weed and liverwort control, are likely to damage some alpine species. A*ubrieta, Erodium, Helianthemum* and *Sedum* can be sensitive to these rates particularly if applied during periods of active crop growth. *Veronica* and *Phlox* have also shown some sensitivity when treated with low rates during late summer. Rates of 1.5-2.7 l/ha might be less phytotoxic if applied during the autumn/winter. For outdoor use only.

The use of all of these herbicides on container-grown alpines is permitted as these herbicides have either approval for ornamental plant production (Flexidor 125 and Ronstar 2G), or can be used under the Long Term Arrangements for Extension of Use (Venzar Flowable), however none have specific label recommendations for use on alpine plants therefore such use is at grower's own risk.

Programme guidelines

Use Ronstar 2G after potting and repeat at up to 12 week intervals depending on weed pressure. Follow with Flexidor 125 for control of chickweed and pearlwort, subject to varietal tolerance (Table 6).

Low rate lenacil (Venzar Flowable) will give additional control of liverwort and weeds if used with Flexidor 125 on outdoor crops, but applications should only be considered in autumn and winter and sensitive species avoided (Table 6).

For short-term alpines, one application of an individual herbicide such as Ronstar 2G or lenacil (Venzar Flowable) may be adequate.

Table 6. Tolerance of container-grown alpines to herbicides

Crop \ Herbicide product	Flexidor 125	Ronstar 2G	Venzar Flowable
Approval status	**A**	**A**	**LTAEU**
Arabis	*		
Aubrieta			
Campanula		**	
Dianthus			
Erodium			
Helianthemum		**	
Phlox		**	***
Primula			
Saxifraga		**	
Sedum		**	
Thymus		**	
Veronica			***

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Approved for ornamental plant production but no label recommendation for alpine crops, therefore use is off-label and at grower's own risk.

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

* Indicates crop damage on *Arabis* when Flexidor 125 used at 0.5 litres/ha.

** Indicates crop damage where Ronstar 2G granules not brushed or rinsed off crop foliage. No damage recorded when granules removed from crop canopy as per label recommendation.

*** Indicates crop damage on *Phlox* (slight) and *Veronica* from Venzar 80WP at 1kg/ha when applied in late summer.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials prior to full scale treatment.

Information sources

HDC projects HNS 35b, HNS 74.

These results refer to the following rates of use:

Product	Product rate
Flexidor 125	1 litre/ha
Ronstar 2G	200kg /ha
Venzar Flowable	2.7-5.0 litres/ha

Heaths and heathers (*Erica, Calluna* and *Daboecia*)

Many species of heaths and heathers are highly sensitive to herbicides, so weed control programmes must rely heavily on good nursery hygiene.

Nursery hygiene

As with other nursery stock crops, good hygiene in stock plant areas, propagation and growing on beds, is vital to achieve good weed control. For heathers, hygiene is particularly important as the sensitivity of the crop to herbicides may require the first application to be delayed until the crop is established. Good hygiene measures of particular relevance to heath and heather production include:

- Ensuring weeds are well controlled in stock beds by using mulches only, no herbicides.
- Using only weed-free batches if cuttings are taken from growing crops.
- Using only clean pots and trays.
- Removal of weeds or moss from modules when potting up.
- Rigorous control of weeds on standing beds, paths and other non-cropped areas.
- Prompt removal of waste from the nursery.
- Segregating of old stock away from newly potted stock.
- Targeting hand weeding to ensure weeds are removed prior to seeding.

Herbicide options

Flexidor 125 (isoxaben)

Can cause growth suppression on some species, however it is particularly useful for the control of severe hairy bittercress infestations. In these situations it is used at half rate (1 litre/ha) when the crop has established. There are no specific label recommendations for use on heaths and heathers, so this use is off-label and at the grower's own risk.

Ronstar 2G (oxadiazon)

Has proved to be the least phytotoxic herbicide used so far on heathers, although most growers still take the precaution of delaying application until the crop is established. The standard rate of 200kg/ha is used. The label recommendation lists *Erica*, but with the warning that some damage is occasionally seen. *Calluna* is not listed on the label, although no phytotoxicity has been reported.

Programme guidelines

Heaths and heathers can be very sensitive to herbicides applied immediately after potting. For this reason many growers prefer to pot the crop and carry out hand weeding during the summer months.

By September the crop should have established and grown up to two thirds of the final plant sale specification. Hand weeding carried out in late August, followed by an herbicide treatment, will maintain crops through mild autumns and the winter thereby reducing hand weeding costs and keeping the crop free of weed for spring sales.

The choice of herbicide depends on which weed is most endemic. The least phytotoxic herbicide used so far is Ronstar 2G applied at standard rate 200kg/ha.

Normally, hand weeding is carried out and the Ronstar 2G granules applied carefully to the crops where the foliage is dry. A special effort is made to remove any lodged granules on the foliage by brushing over the crop with a bamboo cane and a piece of hessian or a motorised blower to blow off the granules onto the growing medium surface.

Where this method has been used over a number of years there is a significant reduction in weed germination and rooting through to the

point of sale some six months later. Only one herbicide application is made.

Where hairy bittercress is a particular problem, the herbicide Flexidor 125 can be used in an emergency to prevent germination of seed infested crops. It also has some effect on young hairy bittercress seedlings.

Heaths and heathers, once established, have some tolerance to Flexidor 125. Usually a half rate application (1 litre/ha) is used and gives adequate control of hairy bittercress germination and establishment for over 12 weeks. It is important that the crop has established before any herbicides are applied.

Non-cropped areas

This section covers weed control in areas where the crop is not present at the time of treatment, including standing beds, and those areas such as pathways and perimeter areas which are not cropped. It is assumed that these areas are in a commercial nursery situation and that there is no general public access. Where there is public access, only chemicals approved for amenity use may be used.

Standing beds

Standing beds are defined as areas on which container-grown plants are stood down for growing on. This includes sand beds, gravel and areas covered with woven plastic ground cover materials.

It is important, between crops, to take the opportunity to clean up the standing bed, whether it is a sand, gravel or woven plastic ground cover bed.

Woven plastic ground covers can be brushed with a stiff broom to remove weeds and debris. These materials can be laid over sand beds in order to reduce problems of weed infestation. There are many different brands of woven plastic ground cover material, so when using a new type on top of capillary sand beds for the first time, it is important always to check the effect on water capillarity and drainage.

Sand, gravel and older woven plastic beds bearing existing weed growth should be sprayed off between crops, using a non-residual contact herbicide such as Finalsan Plus, Harvest, Reglone or Roundup depending on the weeds present. Reglone will give a rapid kill of annual weeds, but if perennial weeds such as pearlwort or thistles are present, Finalsan Plus or Roundup would be preferable, although the latter is slower acting. Where field horsetail is present a Finalsan Plus and Harvest tank mixture is most effective. For willowherbs either Harvest or Shark should be used. Where field liverwort or moss are present or are know to be a potential problem, Finalsan Plus may be used either alone or in tank mix with one of the above herbicides to broaden the weed control spectrum.

There are no label recommendations for use of these herbicides on uncropped sand beds and repeated heavy applications should be avoided.

In the absence of clay colloids and organic matter, heavy doses of these products could lead to herbicide residues at the base of the sand. These treatments are made at the grower's own risk.

Although in many cases the normal application of a residual herbicides over the crop will also give control on the bed area between the pots, on many sites a specific bed treatment will improve weed control. Two treatments that performed well in trials (HDC projects HNS 35d and HNS 167) are Chikara Weed Control (150gm/ha) and Ronstar Liquid + Flexidor 125 (4 litres/ha + 1 litre/ha).

Chikara Weed Control gave effective weed control and suppressed rooting through on some species but has only been tested experimentally on beds subsequently stocked with a limited range of hardy nursery stock

(trees and shrubs). Ronstar Liquid carries a recommendation for use on standing beds, the addition of Flexidor 125, at the grower's own risk, improves the control of pearlwort.

Paths and perimeter areas

Paths and perimeter areas should also be kept clear of weeds in order to prevent infestation spreading to the standing beds. Chikara Weed Control is recommended for use on non-cropped areas and can be particularly useful providing there is no likelihood of run-off onto beds stocked with sensitive species such as herbaceous. Where field horsetail is present Finalsan Plus should be used in a tank mixture with Harvest to give enhanced control with some reduction in re-growth the following year.

Section 1: **Principles of weed control**

Principles of weed control in the field

Introduction

Weeds growing amongst field-grown nursery crops compete for moisture and nutrients and reduce the growth rate of the crop. For example, results from HDC project HNS 78 indicate that allowing weeds to grow in a rootstock crop during the budding season could have far greater effects on bud take than the adverse effects of many herbicides. In extreme cases a dense stand of vegetation can encourage rodent damage, while shading of lower branches may reduce quality. Weeds will also interfere with field operations and look unsightly.

The number and range of weeds can be a major problem in field crops and it is particularly important that a structured approach is taken. This should embrace good husbandry, nursery hygiene and non-chemical techniques where appropriate. Herbicides must be chosen with care and should reflect the weed spectrum. Forward planning is an important cornerstone of a holostic and structured approach. Special attention should be paid to eliminating perennial weeds well in advance of planting. Where the background weed pressure is high, weed control measures should start a full growing season ahead of planting in order to ensure that the land is clean and free from weeds, especially perennial ones.

There is increasing interest in non-chemical weed control methods. This comes against the backdrop of consumer and market driven pressures to reduce pesticide inputs. Such methods improve crop safety and reduce time consuming spray operations. Many non-chemical techniques need only be carried out or applied once, unlike herbicides which often require several top-up treatments. Environmental impact is also minimised and potential difficulties of herbicide residues, as well as resistance amongst some weed populations, are reduced. The use of cultivations can be integrated into an overall weed control strategy which embraces herbicides but which, at the same time, reduces their overall usage.

Herbicides will continue to play an important role in weed control of field-grown nursery stock, although the wide range of species grown makes careful selection of herbicides important. The following sections consider the range of herbicides available and their uses, drawing on the results of HDC and MAFF/Defra funded ADAS trial work.

Weed control strategy

Planning

Weed control planning should start well in advance of planting the crop. Perennial weeds, in particular, are difficult to control once crops have been planted so it is essential to have some knowledge of the extent and range of perennial weeds present in fields due to be planted. Where very difficult weeds such as horsetail or creeping yellow cress are found, it can be worth considering alternative fields. In all cases it will be important to plan for at least one year's fallow or break crop to allow control measures to be taken against perennial weeds. Often the full extent of a perennial weed infestation only becomes apparent during a bare fallow.

A knowledge of the annual weed spectrum of fields is also very valuable. Some idea of likely

weed problems in a new field can be gained by making observations during a preceding fallow. With this information it should be possible to ensure that a planned herbicide programme will control the predominant weeds. Similarly, the range of weeds in any existing planted fields should also be noted so that appropriate herbicides or cultivation techniques can be used.

In some cases it may be appropriate to rely entirely on non-chemical methods of weed control, such as cultivations or mulches. Stock plants and herbicide sensitive crops such as heathers and herbaceous perennials are good examples where this might apply. Soil sterilants may also have a role, particularly where herbicide sensitivity may be an issue, as with seedbeds, young transplants, stock plants and herbaceous divisions lined out for growing on. If it is decided that herbicide use is necessary, the following factors are important when selecting a particular product:

- Is it approved for the intended use and situation?
- Will it control the weed species present or anticipated?
- How persistent is the control, will re-application or cultivation be required later?
- Is it safe for the crop - consider planting similar tolerance crops in blocks?
- Can it be safely prepared and applied with the available equipment?
- Can all usage restrictions be complied with, including timing, age of stock, soil type?
- Does it pose the least risk to human health, the environment and other relevant creatures that may be sensitive to pesticides?

The main source of information to allow a user to use a pesticide safely and effectively is the product label. Information in this weed control guide may be used to select herbicides for programme planning purposes, but it is essential that the product label is read and understood before the product is used as it informs the user on safe and proper use and provides the basic information needed to undertake a COSHH assessment (See Appendix 2).

If it is necessary to use a pesticide, health and safety considerations need to be taken into account. Many pesticides are hazardous to health. COSHH requires a suitable assessment of the risks to health from the use of a pesticide before work starts.

Such assessments must include:

- Consideration of the hazards presented by the pesticide.
- Deciding who could be harmed and how.
- Identifying action to prevent or achieve adequate control of exposure and to comply with COSHH requirements.
- Recording the findings of the assessment when necessary.
- Revising the assessment when required.

Detailed instruction on carrying out COSHH assessments are beyond the scope of this guide, further information can be found in the *Code of Practice for using Plant Protection Products*. Defra, PB11090, http://www.pesticides.gov.uk/Resources/CRD/Migrated-Resources/Documents/C/Code_of_Practice_for_using_Plant_Protection_Products_-_Complete20Code.pdf.

Further consideration should be given to protecting wildlife and the environment. Some details of these aspects are given in the Code of Practice referred to above. Specific aspects are considered in more detail in *Protecting our Water, Soil and Air - A Code of Good Agricultural Practice for farmers, growers and land managers.* Defra, ISBN 978-0-11-243284-5, http://www.defra.gov.uk/publications/files/pb13558-cogap-090202.pdf.

Review

A review process should be built into the programme. It is important to check for signs of herbicide damage, particularly if a new

treatment has been employed. Weed control should be regularly monitored for signs of weed germination. Unexpected weed germination and any changes in the weed spectrum may be a sign of herbicide resistance or a lack of residual herbicide activity. In either case it may be necessary to use further treatments to prevent additional germination, and contact herbicides or cultivation to remove existing weeds.

At the end of the season the effectiveness and safety of the treatments used should be reviewed and used as a basis for developing future policy.

Non-chemical methods of weed control

Background

Until the advent of modern day herbicides in the 1960s, weed control around trees and shrub crops was carried out by horse or tractor-drawn cultivators and hoes between the rows. Hand-hoeing was used to clean weeds growing within the rows. The degree of success throughout the growing year was limited by the weather. The greatest success was achieved in the east of the UK where the rainfall was less than 45cm each year. In wetter conditions in the west, only partial control was achieved.

As tractors became more sophisticated with advanced hydraulic systems, continental manufacturers and growers have developed both mechanical and herbicide weed control machinery, sometimes combining both onto the toolbar mounted between the front and rear wheels, in order to reduce labour. The nursery stock grower in Europe has a wide choice in the range of tractor tool bar equipment to mechanically remove weeds both from within the row and between the rows of stock. In addition, it is possible to apply herbicides precisely in the rows or between them, using equipment mounted on the same tool bar. In recent years reliable GPS Tractor Self-Steering Systems have been developed. These systems use satellite positioning technology to accurately mark out the field in straight lines which then help considerably in planting the crop and enabling subsequent mechanical weed control operations to be carried out with greater precision and so reduce crop damage. Vision guidance systems are also available to precisely guide steerage hoes to enable more accurate control and a faster work rate.

Types of cultivation equipment

Inter-row cultivator

This equipment has a series of tines, which can be spring loaded to prevent shock and which cultivate the top 50-60cm of soil. Single units are 1.0-1.5m wide, mounted on the three-point linkage and used between the rows of trees at wide spacing (1.8-2.0m).

A series of three cultivator tine units on a toolbar can be used between lined out transplants with row spacings of 50cm-1.0m.

Inter-row rotary brush

Consisting of a number of revolving 76cm diameter brushes with high wear resistant bristles, this equipment teases out the weeds growing in the rows. It is possible to work in close crop spacings of 12cm. Rear-mounted on the three-point linkage, the brushes are driven from the PTO shaft. Accurate guidance is achieved with an additional operator steering the unit. Regular use on light soils keeps the weed seedling population low and prevents soil capping.

Telescopic inter-row rotary brush

This equipment uses the rotary brush principle of removing growing weeds. The brushes reciprocate with a sweeping action (usually three units) between the crop rows. Useful for crop row spacings of 1.5-2.5m. The equipment is rear-mounted and driven from the PTO shaft.

Inter-row rotary hoe

Four or five rotary blade units are mounted on a toolbar and driven from the rear power take-off (PTO) shaft. Popular in the 1970s, this equipment is used for low growing stock, 30-90cm in height, where soils are suitable.

Inter-row steerage hoe

This toolbar has the option of fixed or reciprocating blades mounted under the tractor or on the rear hydraulics. When mid-mounted the tractor operator can make fine adjustment to the hoe to avoid the rows of crop plants. With the rear-mounted toolbar, an extra operator is needed to steer the hoe between the rows of plants. Steerage hoes are only suitable for light, friable soils. There are problems with heavy soils in wet years.

Inter-row swinging hoe

Introduced in recent years, this innovative unit uses advanced electronics to manipulate a high tensile sharp blade to hoe out the weeds growing between heavy standard trees at spacings of 1.0m and above. The equipment uses a magic eye to locate the tree stem and the blade reflexes at speed, just in time to pass the tree. The blade then re-engages immediately once the stem is passed and continues to hoe out the weeds.

Alternatively a sensitive pressure bar is used to locate the tree and causes the hoeing blade to reflex swiftly. It is possible to work at speeds of 5 mph using this equipment.

Rotary finger hoe

Very useful for seedlings transplants and bedded stock, this equipment has a series of units (10) mounted on a toolbar which is mid- or rear-mounted on a high clearance tractor such as the Fend GT.

Each unit has two inclined wheels of rubber coated fingers which engage into the soil to remove the weeds.

Gas burners

Weeds can be controlled by burning. A super-charged flame is directed to the weeds growing between rows of plants, the plants being shielded by well-designed steel guards. The unit is mounted on the three-point hitch of the tractor.

Bottled gas (butane or propane) is used to supply the fuel to the burners. Handheld units can be used in more open spaced crops. It should be noted that these units can be a fire hazard on organic soils and where organic mulches are used to suppress weeds.

Soil sterilisation by steam

Injecting steam into the ground will control weeds and also diseases such as Verticillium wilt, providing the critical temperature is achieved and maintained. The use of steam is discussed at greater length in the following section which deals with soil sterilants.

Other techniques

Stale seed beds

The ‘stale seed bed’ technique can be used before seed sowing or planting. The land is prepared well in advance and the weeds allowed to germinate. This weed growth is then controlled before flowering occurs by surface hoeing, cultivations or by burning with a gas fuelled unit.

Research has shown that weed seed germination is reduced if final cultivations are carried out at night. This technique could reduce the dependency on herbicide use and reduce weed germination at planting.

Soil surface mulches

After planting, the soil surface is covered with a membrane or low weed seed organic material which excludes light and so prevents weed germinating and competing with the crop plant.

Mulches have been successfully used over

many years, chiefly on widely spaced stock, both deciduous and evergreen. Mother stock plants and freshly planted stock, in particuar, benefit from the suppression of weed and the reduction of water stress in summer which results from the mulch reducing soil moisture evaporation.

The most common mulches used include:

- Black polyethylene.
- Black polyethylene plus stone chippings.
- Black woven polypropylene.
- Black woven polypropylene plus stone chippings.
- Pine bark.
- Spruce bark.

Less commonly used mulches include:

- Recycled paper plus pine bark chippings.
- Recycled paper mulch plus spruce chippings.
- Composted green waste.

By eliminating light, germination of weed seed is reduced. Providing the mulch stays in place, it can be effective for up to five years. Perennial weeds are not easily controlled by mulches and must be eliminated before planting.

In trials carried out in the 1970s, the use of black polyethylene mulches was shown to give an increase of over 100% in root and shoot growth in the first year. This was achieved by the elimination of weeds and the preservation of the available moisture, enabling establishment during the first season. In the following year, a further increase in growth was noted.

Black polyethylene and polypropylene mulches are normally laid by tractor-mounted mulch laying machinery, using fabric of 1.2m wide and burying the edges to a depth of 15cm. An 'L' shaped cut is made at the mid-point of the mulch and a liner, or plant up to three litres in size, is planted through the mulch. To reduce weeds in the planting hole and hold the fabric in place, gravel is spread around the base of the plants.

Stock plant establishment

Planting stock plants (in rows 1.8-2.0m apart with in row spacings of 0.5-2.0m) through polyethylene makes for ideal establishment and a weed-free area.

Green mulches

In tree and some shrub crops reduction and suppression of weeds can be achieved by under-sowing the crop with ground cover plants such as vetches. If so desired, the 'living mulch' can be kept mown to reduce any competition to the crop. Some 'living mulches' such as buckwheat, have in addition allelopathic effects, directly inhibiting certain weed species.

Organic mulches

To obtain the full benefit from an organic mulch the depth of mulch must be maintained. Organic mulches naturally decompose and also attract vermin which can be troublesome in winter when food is scarce. Damage from mice, shrews and voles can be costly, especially where highly productive mother plants are involved. Birds can also reduce the efficiency of a mulch by searching and scratching for insects, so reducing the depth and capability for the next season. For this reason organic mulches require annual maintenance.

Soil sterilants

Soil sterilants are not widely used for weed control in field-grown nursery stock production as the present range of herbicides available to growers provide adequate weed control in most situations at a lower cost. The main area of use is in outdoor tree seed bed preparation.

Basamid (Dazomet)

Basamid is now the most popular sterilant for nursery stock in field situations such as seed beds. It is formulated as a granular prill and has the advantage that it can be applied by growers themselves. It is capable of providing good levels of weed control, although the longer turn around time (up to six weeks depending on soil temperature) can be a disadvantage. Soil conditions must also be favourable to application as the prill is usually cultivated into the top 15-20cms and then sealed either by rolling or, most usually, with a polythene sheet. Very wet field conditions can therefore hamper application or result in damage to soil structure. Dry field conditions must also be avoided otherwise the release of the sterilant gas, MITC, will be adversely affected. Even and accurate application of the prills, which must be thoroughly mixed into the soil, is essential. The use of Basamid is now restricted to one application in every third year in the same area. This may limit it's usfulness unless sufficient land is available for a three year rotation.

The HDC project HNS 31, highlighted the potential for using a reduced rate of Basamid (100kg/ha) in outdoor seed bed situations where weed control is the priority. In the trial both the recommended (380kg/ha) and reduced rate (100kg/ha) worked well in terms of weed control and the lower rate therefore offers potential to reduce costs. Both treatments also gave rise to improved seedling germination and vigour.

Pest and disease control is also a feature of Basamid when used at recommended rates.

Methyl bromide

The general use of this product has been phased out due to its ozone depleting effect.

Other chemical sterilants

These include chloropicrin and metham sodium. Both of these sterilants have strengths and weaknesses in their spectrum of disease, pest and weed control and such control is also dependent upon dose rate. Few are currently used in nursery stock.

Chloropicrin

Chloropicrin is a liquid which is injected into the soil and covered with plastic. It is relatively weak in terms of weed and nematode control. With regard to disease control, it is highly effective for the control of Verticillium wilt but less effective against *Phytophthora* diseases. All permitted uses of chloropicrin will be withdrawn on 23 June 2013.

Metam-sodium (metham sodium)

Metam-sodium is formulated as a liquid. As with Basamid, it is an MITC generator with activity against insects, some weeds and soil-borne pathogens, principally fungi, and a limited range of nematodes. It is difficult to obtain consistent results with this material because uniform distribution and release of MITC in the soil are dependent on the effectiveness of the soil surface sealing method, the method of application and the texture of the soil. It is however, becoming more widely used in other horticultural crops because of its increasing availability, and the phasing out of methyl bromide. The disadvantages of metam-sodium, compared with methyl bromide, include reduced effectiveness on key diseases and weeds, less flexibility with regard to soil texture and preparation and longer turnaround time.

Steam

When the critical temperature is achieved and maintained, steaming can be a very effective method of weed control. However, many nurseries no longer have steam facilities and would need to hire boilers, which are expensive to fuel. Steam sterilisation is also a lengthy process, with a high labour cost and the time needed to complete the operation can result in delayed planting and crop loss. Handling steam can also be dangerous.

There were experimental portable steam or direct heat units developed in the UK but design considerations and lack of enthusiasm have so far limited uptake of the technique here. In mainland Europe there are contract mobile steam machines, basically an oil- or gas-fired boiler mounted onto a track laying vehicle and featuring hydraulically operated tines which inject steam into the ground to a depth of 30cm. The heat is maintained by insulated covers which are dragged behind the self-propelled, slow moving unit. Temperatures of 100°C can be maintained for 10 minutes.

Section 2: **The weeds**

Weeds of field nurseries

Weed biology

An understanding of the biology and life cycle of weeds will assist in better weed control, whether cultural or chemical. It will also save labour and spray costs through better targeting of the weed control measures employed.

The majority of the weeds found on field nurseries are rapid growing annuals, taking only a short time from germination to flowering. The flowering and germination periods can be seasonal. This information can be used to plan cultivations and to time herbicide applications to ensure that the main germination times are well within the persistence of the herbicide.

Flowering times are important as many weeds are prolific seeders and can spread rapidly through the nursery. A programme of cultivation or directed contact sprays may be necessary if an important weed is coming into flower to avoid its seeds spreading. Knowledge of the source and seed distribution method of weeds is important in developing a hygiene programme for the nursery. Priority should be given to removing weeds with wind dispersed seeds as these are likely to spread most rapidly.

When developing a weed control strategy it is important to first identify the range of weeds present on the nursery and consider which are the most important and the most competitive. This information is essential when drawing up an herbicide programme as most herbicides will only control a specific range of weeds. Over reliance on one herbicide can lead to a build up of resistant weeds.

Some weeds are easier than others to hand weed. Control of the difficult to weed subjects must be given priority whilst the weeds are small.

Perennial weeds may be a problem in longer term field crops such as heavy trees. Although there are a few selective treatments available for established crops, in general the main approach for control has to be thorough cleaning of the land prior to planting.

Weed profiles

This section includes a description of the key weeds that are often associated with field-grown nursery stock along with their distribution on nurseries and their methods of dispersal.

Information is also given on the relative effectiveness of herbicides against each key weed. This information is largely drawn from the results of HDC projects HNS 31, HNS 31a, HNS 78, HNS 139 and HNS 155. Note that herbicides are listed for their residual effect on annual weed germination. Some of the herbicides mentioned may only be applicable for certain crops and for outdoor application only. Many do not possess label recommendations for use on nursery stock but may be used off-label either under an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) or via the Long Term Arrangements for Extension of Use (LTAEU). These are indicated as off-label approvals and may only have limited applications or uses. Further information on individual herbicides is given in Section 3.

Annual meadow-grass (*Poa annua* L.)

Characteristics

A low spreading annual grass, sometimes perennial, 5-30cm. Leaves hairless. Flower spikelets 3-10mm long, 3-10 flowers.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■	■	■	■	■	■	

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■	■	■	■	■	■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed in Britain, found in arable fields, particularly compact, nutrient rich soils.

Seed dispersal

The seed can be spread by wind, water and animals.

General information

Although low growing, annual meadow-grass is quite competitive. Flexidor 125 does not control annual meadow-grass, so over-reliance on Flexidor 125 in the herbicide programme will lead to a build up of this weed.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Intruder, Ronstar Liquid.
- Off-label: Artist, Dual Gold, Springbok, Stomp Aqua, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone.
- Off-label: Aramo, Goltix WG, Roundup.

Bindweed, black (*Fallopia convolvulus L.*)

Characteristics

A vigorous climbing annual. The leaves are heart-shaped, mealy below. The flowers are small, greenish-pink in loose spikes.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■					

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■						

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Common in fertile, sometimes acid, sandy or loam soils.

Seed dispersal

The seed can be spread by animals, water and locally by wind.

General information

Vigorously competitive with most nursery crops, the stems can become entangled in crop foliage making lifting and other operations difficult. Black bindweed is capable of germinating from depths of 10cm or more, sometimes via soil cracks and often below the herbicide layer.

Control measures

Herbicides pre-emergence

- On-label: Flexidor 125, Intruder, Ronstar Liquid.
- Off-label: Stomp Aqua, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Shark, Sumimax.

Charlock (*Sinapis arvensis* L.)

Characteristics

Medium-tall bristly annual. Lower leaves large, lobed, and toothed. Flowers 20mm yellow.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed on fertile moderately light arable soils.

Seed dispersal

The seeds are spread by wind, water and animals.

General information

A moderate competitor, but tends to form dense populations. Well controlled by a number of herbicides.

Control measures

Herbicides pre-emergence

- On-label: Flexidor 125, Ronstar Liquid.
- Off-label: Artist, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup.

Chickweed, common (*Stellaria media* (L.) Vill.)

Characteristics

A vigorous low spreading annual. Stems weak with a line of hairs. Leaves oval, bright green, the lower long-stalked. Flowers 8-10mm, petals white, cleft to base.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			■	■	■	■					

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■	■	■	■	■	■	

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed in arable fields and nurseries.

Seed dispersal

The seed is slightly sticky and can be spread on cutting material as well as by wind, water and animals.

General information

Vigorous growth particularly in the autumn can readily choke young plants and affect quality. Ronstar Liquid does not control common chickweed so over reliance on this herbicide will lead to a build up of this weed.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Flexidor 125, Intruder.
- Off-label: Artist, Centium 360 CS, Dual Gold, Springbok, Stomp Aqua, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Intruder, Reglone.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Sumimax.

Cleavers (*Galium aparine* L.)

Characteristics

A moderate tall scrambling annual, clinging to plants and animals by virtue of numerous tiny down-turned prickles along the stems. Leaves narrowly elliptical in whorls of 6-8. Flowers insignificant, white.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■			

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■					■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widespread in arable and nursery fields, particularly on heavier alkaline soil types. With large seeds, it is capable of germinating from depth, and in cracks between clods.

Seed dispersal

The large seed has numerous small hooked bristles enabling it to be spread on clothing, animal fur and on plant material.

General information

The vigorous growth and scrambling habit can choke young plants and can be difficult to weed when established. Contact herbicides are not always effective, as the leaf and stem surface is difficult to penetrate. Re-growth can also occur from the base of the stem.

Control measures

Herbicides pre-emergence

- On-label: Ronstar Liquid.
- Off-label: Centium 360 CS, Springbok.

Herbicides post-emergence

- On-label: Finale, Ronstar Liquid.
- Off-label: Centium 360 CS, Roundup, Shark.

Crane's-bill, dove's-foot (*Geranium molle* L.)

Characteristics

A low growing rosette forming plant, increasingly common in arable and horticultural field crops.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Cultivated land, particularly dry sandy soils.

Seed dispersal

Seeds are locally spread by the dispersal mechanism of the drying seed pod and can be spread further by animals.

General information

Low growing but can become abundant and troublesome because a number of commonly used herbicides do not control it.

Control measures

Herbicides pre-emergence

- On-label: Ronstar Liquid.
- Off-label: Centium 360 CS, Dual Gold, Goltix WG, Springbok.

Herbicides post-emergence

- On-label: Finale.
- Off-label: Goltix WG, Roundup, Shark, Sumimax.

Dead-nettle, red (*Lamium purpureum* L.)

Characteristics

Low growing, purplish downy annual. Leaves heart shaped, bluntly toothed, rugose. Flowers pink.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Found on cultivated land throughout Britain, particularly on heavier soil types rich in nutrients.

Seed dispersal

The seed is dispersed by the action of the seed capsule, wind and animals.

General information

Dead-nettles are moderate to strong competitors. However they are normally well controlled by a range of pre- and post-emergence herbicides.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Flexidor 125, Ronstar Liquid.
- Off-label: Arist, Centium 360 CS, Dual Gold, Springbok, Stomp Aqua, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Sumimax.

Fat-hen (*Chenopodium album* L.)

Characteristics

Tall growing, mealy covered annual. Leaves oval to diamond shaped, toothed. Small greenish white flower in clusters from leaf axils.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■	■	■	■	■	■	

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common in cultivated land throughout Britain, particularly in spring planted or drilled crops. Very large numbers of seed can be present and the seed is known to remain viable for several years. Less frequently found in undisturbed soil.

Seed dispersal

The seed is dispersed by wind, water and animals.

General information

A large bulky and competitive weed, which can rapidly shade out smaller crop plants. It is normally well controlled by a range of pre-emergence herbicides, however very large quantities of seed may be present on some sites allowing a small percentage to still present a problem. It is relatively easy to cultivate out when small, and can be controlled post-emergence by a range of contact herbicides.

Control measures

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Ronstar Liquid.
- Off-label: Artist, Stomp Aqua, Sumimax, Venzar Flowable.

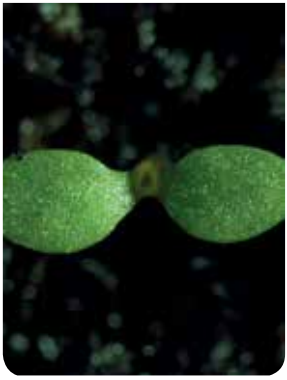
Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Shark, Sumimax.

Fleabane, Canadian (*Conyza canadensis* (L.) Cronq.)

Characteristics

A tall annual or biennial, moderately hairy. Leaves narrow, pointed, sometimes toothed. Flowerheads with small almost petal-less flowers in loose branched spikes somewhat like 'Golden Rod'.



Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■	■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Locally abundant, particularly on undisturbed light soils, rich in nutrients.

Seed dispersal

Flowerheads produce abundant wind dispersed seeds which spread rapidly and germinate readily.

General information

A few plants can rapidly produce enormous quantities of viable seed, so populations can rapidly build up if seeding plants are not removed early. Although some seeds germinate in the spring, germination can take place during the summer and autumn when spring applied herbicides have reduced residual activity.

Control measures

Herbicides pre-emergence

- On-label: Butisan S.
- Off-label: Artist.

Herbicides post-emergence

- On-label: Dow Shield 400, Finale, Finalsan Plus.
- Off-label: Roundup.

Groundsel (*Senecio vulgaris* L.)

Characteristics

A short growing annual with erect succulent stems, slightly glabrous. The leaves are pinnately lobed either short stalked or half clasping the stem. The flowerheads are small, brushlike, yellow, in loose clusters. When mature the seed heads are fluffy and readily dispersed.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Very widely distributed on nurseries on a full range of cultivated and undisturbed soils, sometimes a past legacy of widespread use of simazine (to which it was resistant).

Seed dispersal

The wind dispersed seed can spread the weed rapidly throughout the nursery. Even small plants can set seed under the right conditions.

General information

The abundance of seed and subsequent seedlings makes groundsel a particular problem which has increased in recent years. Groundsel seed is viable before the plant is fully mature, so even plants still in flower will have viable seed. However, for groundsel seed survival is short and most will germinate in the first year. Groundsel is susceptible to a species of rust that can spread to certain ornamental grasses.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Ronstar Liquid.
- Off-label: Artist, Centium 360 CS, Dual Gold, Springbok, Sumimax.

Herbicides post-emergence

- On-label: Dow Shield 400, Finale, Finalsan Plus, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Sumimax.

Horsetail, field (*Equisetum arvense* L.)

Characteristics

A troublesome very deep rooted rhizomatous perennial of uncultivated land that encroaches into field margins, propagation areas, container beds and field grown crops.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■					

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■	■	■				

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed in uncultivated areas around nurseries.

Seed dispersal

Although spread can occur through spore dispersal during May-July, the spores are short lived. The main method of spread is by vegetative reproduction of detached rhizomes and tubers in March-May and again from October-November

General information

Field horsetail can form a very dense low mat of foliage that restricts crop growth and impedes lifting of field crops. It can easily penetrate polythene lined sand beds and even asphalt roadways from below. Once established in a field it can be almost impossible to eradicate although amelioration measures can contain its growth.

Control measures

Herbicides pre-emergence

- On-label: None.
- Off-label: None.

Herbicides post-emergence

- On-label: Finalsan Plus, Finale.
- Off-label: 2,4 D, MCPA, Weedazol-TL (all pre-planting only).

Knotgrass (*Polygonum aviculare* agg.)

Characteristics

Flat growing hairless perennial with branched wiry stems and small lanceolate leaves forming a low mat over the soil surface. Flowers small, pinkish, clustered at the base of upper leaves.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■						

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common weed of arable and nursery fields, both in cultivated and uncultivated areas.

Seed dispersal

Prolific seed is cast in the vicinity of the parent plant. Seed can also be dispersed by animals, rainwater and wind.

General information

Mature knotgrass is moderately competitive and forms a tough wiry mat that is difficult to hand-weed and can make lifting difficult. Once established the weed can be difficult to kill with contact herbicides although glyphosate is effective. Germination is limited to the spring period.

Control measures

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Intruder, Ronstar Liquid.
- Off-label: Artist, Stomp Aqua, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Ronstar Liquid, Roundup.
- Off-label: Goltix WG.

Nettle, small (*Urtica urens* L.)

Characteristics

Medium growing annual covered with stinging hairs. Leaves oval, pointed and toothed. Flowers small, insignificant. The annual nettle can be easily uprooted, revealing white roots, unlike the similar but taller perennial nettle (*Urtica dioica*) which is more difficult to uproot and has tough yellow roots.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■			

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■	■	■	■	■		

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Found in cultivated land throughout Britain, particularly nutrient rich soils of medium to light texture. Less frequently found in undisturbed soil. As a result of the short time from germination to flowering, annual nettle is well adapted to frequently cultivated land.

Seed dispersal

The seed is dispersed by wind, water and birds.

General information

Annual nettle is a moderate competitor, but has a considerable nuisance factor for staff working in the field because of the stinging hairs. Annual nettle is normally well controlled by a range of pre-emergence herbicides although on some nutrient rich sites, the abundance of seed results in apparently poor control. There are marked differences in the efficacy of commonly used contact herbicides, Finale being more effective than glyphosate.

Control measures

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Intruder, Ronstar Liquid.
- Off-label: Artist, Springbok, Stomp Aqua, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Shark, Sumimax.

Nightshade, black (*Solanum nigrum* L.)

Characteristics

A short/medium annual, stems often blackish. Leaves pointed sometimes downy. The flowers are medium sized, white, with a distinctive centre of yellow anthers.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						■	■	■			

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■	■			

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Common in arable and nursery land, particularly where the soil is cultivated during the summer months and in seasons where there is adequate rainfall during the summer.

Seed dispersal

Seed is dispersed by water and animals.

General information

Individual plants can become large and competitive. Nightshade germination can vary from season to season according to summer rainfall. Germination can occur at a time of year when spring applied herbicides have reduced residual activity.

Control measures

Herbicides pre-emergence

- On-label: Ronstar Liquid.
- Off-label: Stomp Aqua, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone, Ronstar Liquid.
- Off-label: Roundup, Sumimax.

Orache, common (*Atriplex patula* L.)

Characteristics

Medium, mat-forming annual with mealy triangular leaves. Sometimes confused with knotgrass. Small flowers in greenish clusters, inconspicuous.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■	■						

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Arable and nursery fields on fertile soils, both cultivated and undisturbed.

Seed dispersal

The seed is dispersed over longer distances by water and animals, over shorter distances by wind.

General information

A moderate competitor, low growing but mat forming. A single plant can cover a large area once established. It can be difficult to weed out and makes lifting or budding difficult.

Control measures

Herbicides pre-emergence

- On-label: Flexidor 125, Ronstar Liquid.
- Off-label: Artist, Stomp Aqua, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup.

Pansy, field (*Viola arvensis* Murray)

Characteristics

Low growing, slightly hairy annual. Leaves broad, semi-pinnate. Flowers single, cream coloured with yellow or purplish tinge, darker veins.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■	■	■	■	■	□	

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
□	■	■	■	□				□	■	■	■

■ main period of germination/flowering

□ germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common in cultivated land throughout Britain, particularly in autumn planted or drilled crops. Less frequently found in undisturbed soil.

Seed dispersal

The seed is dispersed by rapidly opening seed capsule and by animals.

General information

Field pansy is a moderate to vigorous competitor. It is normally well controlled by a range of pre-emergence herbicides, however it can be problematical where selective herbicides such as Venzar Flowable are used. It is relatively easy to cultivate out, and can be controlled post-emergence by a range of contact herbicides.

Control measures

Herbicides pre-emergence

- On-label: Flexidor 125.
- Off-label: Artist, Stomp Aqua, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Shark, Sumimax.

Pineapple-weed (*Matricaria matricariodes* Porter)

Characteristics

Low growing, hairless annual, pineapple scented. Leaves filigree, 2-3 pinnate. Flowers single ray-less (no petals), bracts pale edged. Two similar common mayweeds are: scentless mayweed (*Tripleurospermum inodorum)*, leaves scentless, flowers with white rays (petals) and scented mayweed (*Matricaria recutita)*, leaves scented, more erect, flowers with white rays down-turned.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common in cultivated land and undisturbed compacted soils throughout Britain.

Seed dispersal

The seed is dispersed by wind and animals and can be spread via mud on vehicle wheels.

General information

Mayweeds are moderate competitors. They are one of the most commonly found weeds of field nurseries. Although controlled by a number of pre-emergence herbicides, some of the commonly used products such as Stomp Aqua fail to give control. They can be controlled post-emergence by a range of contact herbicides including some selective treatments.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Flexidor 125, Ronstar Liquid.
- Off-label: Artist, Centium 360 CS, Dual Gold, Springbok, Sumimax.

Herbicides post-emergence

- On-label: Dow Shield 400, Finale, Reglone, Ronstar Liquid.
- Off-label: Goltix WG, Roundup, Sumimax.

Poppy, common (*Papaver rhoeas* L.)

Characteristics

Medium height, slender annual. Leaves hairy, lobed. Flowers single, large, distinctive, scarlet with dark centre.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■	■			■	■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Common in cereal fields, and autumn planted crops on moderate to light soils, nitrogen rich.

Seed dispersal

The seed is dispersed by wind, water, or on plant material.

General information

A moderate competitor, but relatively easy to cultivate out or control with contact herbicides.

Control measures

Herbicides pre-emergence

- On-label: Devrinol, Flexidor 125, Intruder.
- Off-label: Springbok, Stomp Aqua.

Herbicides post-emergence

- On-label: Finale, Reglone.
- Off-label: Betanal Flowable, Goltix WG, Roundup.

Redshank (*Polygonum persicaria* L.)

Characteristics

Medium growing, sprawling hairless annual. Leaves long, narrow, dark spotted and tapered at base. Flowers pink in short spikes.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					■	■	■	■	■		

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		■	■	■	■	■					

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common in cultivated land throughout Britain, particularly in water retentive, fertile and silty soils. Less frequently found in undisturbed soil.

Seed dispersal

The seed is dispersed by wind, animals and surface water.

General information

Redshank is a moderate competitor. It germinates readily in the spring and dense stands of the weed can develop by early summer shading out low growing crops. They are normally well controlled by a range of pre-emergence herbicides, but the seedlings are difficult to control once emerged.

Control measures

Herbicides pre-emergence

- On-label: Flexidor 125, Intruder, Ronstar Liquid.
- Off-label: Artist, Stomp Aqua, Venzar Flowable.

Herbicides post-emergence

- On-label: Dow Shield 400, Finale, Reglone, Ronstar Liquid.
- Off-label: Goltix WG, Roundup, Shark.

Shepherd's purse (*Capsella bursa-pastoris* (L.) Medicus)

Characteristics

Medium-low growing, annual or biennial. Leaves spear-shaped, lobed, forming a rosette. Flowers small, white. Distinctive seed pods, purse shaped.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Extremely common weed of cultivated land throughout Britain, particularly in spring planted or drilled crops. Less frequently found in undisturbed soil. As a result of the short time from germination to flowering, shepherd's purse is well adapted to frequently cultivated land.

Seed dispersal

The seed is dispersed by wind, water and animals.

General information:

Shepherd's purse is a moderate to strong competitor. It is normally well controlled by a range of pre-emergence herbicides although resistant to Devrinol. It is relatively easy to cultivate out, and can be controlled post-emergence by a range of contact herbicides.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Flexidor 125, Ronstar Liquid.
- Off-label: Artist, Centium 360 CS, Dual Gold, Springbok, Stomp Aqua, Sumimax, Venzar Flowable.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Goltix WG, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Roundup, Shark, Sumimax.

Speedwell, common field (*Veronica persica* Poiret)

Characteristics

Low growing, sprawling hairy annual. Leaves oval, short stalked, light green, hairy on veins below. Flowers single, light blue with darker veins.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Very common in cultivated land throughout Britain, particularly in spring planted or drilled crops. Less frequently found in undisturbed soil.

Seed dispersal

The seed is dispersed by wind over short distances.

General information

Speedwells are moderately weak competitors. They are normally well controlled by a range of pre-emergence herbicides, however they can be problematical where selective herbicides such as Venzar Flowable are used. They are relatively easy to cultivate out, and can be controlled post-emergence by a range of contact herbicides.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Flexidor 125, Intruder, Ronstar Liquid.
- Off-label: Artist, Centium 360 CS, Dual Gold, Springbok, Stomp Aqua, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Reglone, Ronstar Liquid.
- Off-label: Betanal Flowable, Goltix WG, Roundup, Shark, Sumimax.

Willowherb (*Epilobium* spp.)

Characteristics

There are a number of different species, the most common are small/medium perennials. Leaves, alternate, lanceolate with small pale pink flowers maturing into fluffy seed heads. The abundant seedlings develop into glossy compact rosettes which overwinter before flowering. After senescence of the flower stem the basal rosette can re-grow.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■	■	■				

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
■	■	■	■	■			■	■	■	■	■

■ main period of germination/flowering

■ germination/flowering may also occur during this period if conditions are favourable

Distribution

Widely distributed and increasing on nurseries, particularly on undisturbed soil. Path and tunnel edges, waste and perimeter areas can often be infested with this weed particularly where ground is moist and other weeds have been controlled by herbicides.

Seed dispersal

Spread by wind dispersed seeds that are produced from the fluffy seed heads of mature plants.

General information

A significant problem for some nurseries because of the rapid and abundant germination of seedlings. It is relatively easy to hand weed or cultivate out however. The careful choice of herbicides is required for post-emergence control as some merely scorch the top growth leaving the basal rosette to re-grow.

Control measures

Herbicides pre-emergence

- On-label: Butisan S, Devrinol, Ronstar Liquid.
- Off-label: Artist, Dual Gold, Springbok, Sumimax.

Herbicides post-emergence

- On-label: Finale, Finalsan Plus, Ronstar Liquid.
- Off-label: Roundup, Shark, Sumimax.

Yellow-cress, creeping (*Rorippa sylvestris* (L.) Besser)

Characteristics

A low growing, perennial weed with creeping rhizomatous roots and golden yellow flowers.

Flowering period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Germination period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

main period of germination/flowering

germination/flowering may also occur during this period if conditions are favourable

Distribution

Prefers damp light soils rich in nitrogen. Often found in uncultivated fields and in fields used for nursery stock production. Established patches tend to remain from year to year.

Seed dispersal

Although seed is produced, the main method of spread is through vegetative reproduction. Detached segments of the fleshy white roots become intertwined with the crop roots and can be lifted with field-grown nursery stock and spread to new sites when planted.

General information

Although not widely distributed this is a serious weed problem where it occurs. The established weed is low growing but forms a dense canopy and is very competitive for water and nutrients. Patches of creeping yellow cress can be difficult to control in a crop and there is a real risk of spread from root segments in lifted stock.

Control measures

Herbicides pre-emergence

- On-label: None.
- Off-label: None.

Herbicides post-emergence

- On-label: None.
- Off-label: Timbrel, Weedazol-TL (both pre-planting only).

Section 3: **The herbicides**

Herbicides

It is important to understand the different types of herbicides available and their suitability for different uses.

The factors affecting the efficacy and safety of herbicides should always be considered before making herbicide applications.

The herbicide profiles contain reference information about individual products. This is intended to provide background information about the suitability of the product for a particular use, its likely safety and efficacy, and other information to be considered before use. It is not intended to provide all the information on the product label.

The product label must always be consulted before use.

Herbicide types

Herbicides can be classified according to their activity against weeds and also according to their selectivity to the crop.

Pre-weed emergence – residual, soil acting

The majority of herbicides used in field-grown nursery stock production are residual. They are applied to a weed-free soil surface and have a persistent effect, preventing weeds from germinating or emerging. Flexidor 125 is an example of this type of herbicide.

Most residual herbicides used in nursery stock are also crop tolerant in that they can be applied over the foliage of the crop without causing damage. This selectivity may, however, depend on the crop species and in some cases the time of year or crop growth stage. Ronstar Liquid, for example, would be damaging if applied to the foliage of a nursery stock crop during the growing season, but can be applied overall to dormant trees during the winter.

Contact and/or translocated – foliar acting

The foliar acting herbicides generally have a direct action on the weed foliage and can either be translocated, e.g. glyphosate, where the herbicide can travel from the sprayed leaves to affect other parts such as the roots, or purely contact, e.g. diquat, where the herbicide only affects the parts sprayed. Most of these herbicides are also non-crop tolerant, that is they damage crops if applied over them, so their use is restricted to directed sprays to clean up weeds in alleys between crop rows.

Some herbicides with contact activity are crop tolerant and can be used to control weeds already present within a crop. There are relatively few examples of this category used in nursery stock production.

A number of residual soil acting herbicides also have useful post-emergence activity against certain seedling weeds. Often this is through root uptake, but sometimes also through a direct scorch to the foliage. Butisan S can affect a range of emerged seedling weeds and Ronstar Liquid has a strong contact action on many weeds, including field bindweed.

Pre or post-emergence

An alternative term often used is pre- or post-emergence. In agriculture this generally refers to the use of the herbicide either pre- or post-emergence of the crop. However in perennial crops such as nursery stock, it is generally used in reference to the weed, e.g. use pre- or post-weed emergence.

Practical usage – factors affecting efficacy

Many soil acting herbicides do not work well under dry conditions. This can be a problem with late spring or summer applications although overhead irrigation can help. Some herbicides are also vulnerable to breakdown by light including Flexidor 125 and Devrinol and should preferably be applied on a dull day and irrigated in as soon as possible.

The water volume for spray application should be selected according to the label recommendation. At higher volumes it is easier to achieve good cover where there is a lot of crop or weed foliage.

The expected persistence of a residual herbicide should be noted so that a follow-up application can be planned before weeds starts to germinate. In most cases, control is less efficient once weeds have been allowed to emerge. Conversely, top-up applications should not be made too soon because of the risk of crop damage from overdosing.

Soil type can have an influence on the crop selectivity and efficacy of residual herbicides. In several cases lower rates of use are recommended on light soils compared with those for heavy soil. Very few herbicides are recommended for use on peat soils.

Approval categories

On-label approval

Many herbicides listed in this guide are approved for use on nursery stock crops and have on-label recommendations for use. If label recommendations are followed precisely, then liability, for example, crop damage, will be covered by the marketing company. Use on a crop not listed on the label will not be covered by the marketing company in the case of any crop damage so growers are advised to test a small area first before treating the whole crop. This use will be at grower's own risk.

Off-label approval

Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product

Some herbicides have an off-label approval for use in ornamental plant production. The approval terminology has recently changed and Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) has replaced Specific Off-Label Approval (SOLA).

These are uses for which approval has been sought by individuals or organisations such as the HDC. Users of EAMUs must obtain a copy of the relevant Notice of Approval and comply strictly with the conditions. Any use of these products is entirely at the grower's own risk.

The Long Term Arrangements for Extension of Use

A further range of herbicides listed in this guide have no label approval or EAMU for use on nursery stock crops. Provided they are approved for use on a growing crop they may be used off-label under the Long Term Arrangements for Extension of Use (LTAEU) on ornamental crops such as nursery stock, subject to certain conditions. Any use of these products is entirely at the grower's own risk.

The Long Term Arrangements are gradually being withdrawn as products are re-registered and herbicides currently being used under these arrangements are being reviewed by the Chemicals Regulation Directorate (CRD). Where operator safety is considered acceptable, an EAMU is issued and the herbicide can continue to be used under the terms of the EAMU. If,

following review, an EAMU is refused, the herbicide can no longer be used under the Long Term Arrangements.

Growers should acquaint themselves with developments and changes that are taking place with the Long Term Arrangements and be aware of any new EAMU for herbicides that become available to replace them. The best way to keep up to date is by using the link to the Liaison LTAEU database from the HDC website.

Timing of herbicide use

There are three main timings of herbicide use for weed control in field-grown nursery stock.

Pre-planting

Application of translocated herbicides for perennial weed control well ahead of planting the crop, and contact herbicides for cleaning up annual weeds that have germinated immediately prior to planting.

Herbicides should be selected on the basis of weed control (Table 7), and bearing in mind any required interval between application and planting the crop.

Post-planting

Application of residual herbicides immediately after planting (Table 8), selected according to safety to crop species and safety on newly planted crops (Tables 11, 12 and 13).

Within crop

Application of herbicides within the crop (including top-up applications of residual herbicides) to maintain pre-emergence weed control, and contact herbicides to control emerged weed, either selective (applied over the crop foliage), or non-selective (applied as a directed spray) see Tables 9 and 10.

Pre-planting treatments

Perennial weed control

Most perennial weeds are deep rooted and cannot be easily controlled without some risk to nursery stock crops. There are relatively few selective herbicides for the control of perennial weeds once the crop has been planted. It is therefore important to plan a programme of perennial weed control in the season before the crop is due to be planted.

The choice of herbicide will depend on the weeds present and the time available between herbicide application and planting. In most cases glyphosate will control the range of weeds present, but for resistant weeds such as creeping yellow-cress and field horsetail other alternatives are required, some of which require a longer interval before planting, see Table 7 overleaf.

Annual weed control

If only annual weeds are present and a quick clean up is required just before planting, cultivations may be sufficient. Alternatively a contact non-translocated herbicide, such as a formulation of diquat or glufosinate-ammonium, could be used.

Allow three days between treatment and planting.

Table 7. Susceptibility of perennial weeds to herbicides, pre-planting

Weed \ Herbicide product	Dow Shield 400	Finale*	Finalsan Plus	Roundup	Timbrel	Weedazol-TL
Approval status	**A**	**A**	**A**	**A**	**LTAEU**	**A**
Bindweed						
Bracken						
Buttercup, creeping						
Clover						
Couch grass						
Dandelion						
Dock						
Hogweed						
Horsetail, field						
Nettle, perennial						
Thistle, creeping						
Yellow-cress, creeping						
Time before planting (wks)	Depends on crop	Not specified On-label	Not specified	1	6	12

Susceptible	Moderately susceptible	Moderately resistant	Resistant

A Label approval.

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

* Non translocated so weed re-growth can occur

Post-planting treatments

There is a range of residual herbicides with recommendations for use in field-grown nursery stock, but some may not be safe to certain crops. Alternatively non-chemical methods of weed control, such as soil cultivations, may be used initially or as a clean up following a short-term herbicide application. Generally such methods are most successful on lighter soil under dry conditions.

The following tables contain information about the most common weeds found in field nurseries and the activity of herbicides against them. Some residual herbicides also have a contact action so can only be used on newly planted crops that are dormant, as directed sprays avoiding foliage or during the winter on dormant deciduous crops. Others may be safely used over crop foliage.

Table 8. Susceptibility of annual weeds to herbicides, pre-weed emergence

Herbicide product / Weed	Artist*	Butisan S	Centium 360 CS*	Devrinol	Dual Gold	Flexidor 125	Intruder*	Ronstar Liquid*	Springbok	Stomp Aqua	Sumimax*	Venzar Flowable
Approval status	LTAEU	A	LTAEU	A	LTAEU	A	A	A	LTAEU	EAMU	EAMU	LTAEU
Annual meadow-grass												
Bindweed, black												
Charlock												
Chickweed, common												
Cleavers												
Corn spurrey												
Crane's-bill, dove's-foot												
Dead-nettle, red												
Fat-hen												
Fleabane, Canadian												
Fumitory, common												
Groundsel												
Knotgrass, common												
Mayweed												
Nettle, small												
Nightshade, black												
Orache, common												
Pansy-field												
Penny-cress, field												
Poppy, common												
Redshank												
Scarlet pimpernel												
Shepherd's purse												
Sow-thistle, common												
Speedwell, common												
Volunteer cereals												
Wild oat												
Willowherbs												

Susceptible | Moderately susceptible | Moderately resistant | Resistant

A Label approval.

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

* Significant contact action and should not be applied over crop foliage

Table 9. Susceptibility of perennial weeds to herbicides, post-weed emergence

	(a) Herbicides which are selective in certain crops					(b) Herbicides which are non selective (cannot be applied over crop foliage)					
Herbicide product / **Weed**	Aramo	Betanal Flow	Dow Shield 400	Goltix WG	Laser	Finalsan Plus	Finale *	Reglone *	Ronstar Liquid **	Roundup	Shark
Approval status	A	EAMU	A	LTAEU	LTAEU	A	A	A	A	A	EAMU
Buttercup, creeping											
Bindweed, field											
Clover											
Couch grass											
Dandelion											
Dock											
Hogweed											
Horsetail, field											
Nettle, perennial											
Thistle, creeping											
Yellow-cress, creeping											

Susceptible | Moderately susceptible | Moderately resistant | Resistant

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

* Non translocated so weed re-growth will occur.

** Selectivity depends upon dormancy of the crop.

Table 10. Susceptibility of annual weeds to herbicides, post-weed emergence

	(a) Herbicides which are selective in certain crops					(b) Herbicides which are non selective (cannot be applied over crop foliage)						
Herbicide product / **Weed**	**Aramo**	**Betanal Flow**	**Dow Shield 400**	**Goltix WG**	**Laser**	**Finale ***	**Finalsan Plus**	**Reglone ***	**Ronstar Liquid ****	**Roundup**	**Shark**	**Sumimax ***
Approval status	**A**	**EAMU**	**A**	**LTAEU**	**LTAEU**	**A**	**A**	**A**	**A**	**A**	**EAMU**	**EAMU**
Annual meadow-grass	S	R	R	S	R	S	S	S	R	S	R	M
Bindweed, black	R	S	M	S	R	S	W	M	S	S	S	S
Charlock	R	S	R	S	R	S	W	S	S	S	W	W
Chickweed, common	R	S	M	S	R	S	S	S	W	S	W	S
Cleavers	R	M	R	R	R	S	W	M	S	S	S	M
Corn spurrey	R	M	R	S	R	S	S	S	S	S	W	W
Crane's-bill, dove's-foot	R	W	S	S	W	S	W	W	W	S	S	S
Dead-nettle, red	R	S	R	S	R	S	S	S	S	S	W	S
Fat-hen	R	S	M	S	R	S	S	S	S	S	S	S
Fleabane, Canadian	R	W	S	W	R	S	S	W	W	S	W	S
Fumitory, common	R	S	R	S	R	S	S	S	S	S	W	W
Groundsel	R	S	S	S	R	S	S	S	S	S	M	S
Knotgrass, common	R	M	M	S	R	S	S	M	S	S	S	M
Mayweed	R	M	S	S	R	S	W	S	S	S	W	S
Nettle, small	R	S	R	S	R	S	S	M	S	M	S	S
Nightshade, black	R	M	M	M	R	S	S	S	S	S	W	S
Orache, common	R	S	W	S	R	S	W	S	S	S	W	W
Poppy, common	R	S	R	S	R	S	W	S	W	S	W	W
Pansy, field	R	S	R	S	R	S	S	S	W	S	S	S
Penny-cress, field	R	M	W	S	R	S	W	S	W	S	W	S
Red shank	R	M	M	S	R	S	W	S	S	S	S	W
Sow-thistle, common	R	W	M	S	R	S	S	S	S	S	S	S
Speedwell, common	R	S	M	S	R	S	S	S	S	S	S	S
Scarlet pimpernel	R	S	R	S	R	S	W	S	W	S	W	W
Shepherd's purse	R	S	R	S	R	S	S	S	S	S	S	S
Volunteer cereals	S	W	R	W	S	S	W	S	W	S	R	W
Wild oat	S	W	R	W	S	S	S	S	W	S	R	W
Willowherbs	R	W	M	W	R	S	S	M	S	M	S	S

Susceptible	Moderately susceptible	Moderately resistant	Resistant

A Label approval.

EAMU Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk use).

* Non translocated so weed re-growth will occur.

** Selectivity depends upon dormancy of the crop.

Herbicides with label recommendations

Herbicides with label recommendations for use in field-grown nursery stock

The following products have label recommendations for use in field-grown nursery stock. Information in this section is taken from the marketing company's label recommendations, except for the sections 'additional information' and, where applicable, 'experimental information' which are based on results of HDC trials and commercial practice.

These profiles are presented in alphabetical order of the typical product.

Other registered products with the same active ingredient as the typical products above are listed at the end of the section.

Always read the product label, use pesticides safely.

Butisan S

Active ingredient

Metazachlor (500g/litre).

Formulation

Suspension concentrate.

Supplier

BASF plc.

Mode of action

Residual, soil acting, contact activity against emerged weeds.

Label recommendations

Ornamentals and hardy nursery stock. Label gives a range of tree and shrub species which may be treated.

Rates of use

0.66–1.5 litres/ha (in 220-450 litres of water/ha).

Timing

After planting and in established plantings.

Label use restrictions

Applications are limited to a total dose of not more than 2 litres/ha in a three year period on the same field. This is equivalent to 0.66 litres/ha per year. Do not apply to plants with soft vigorously growing foliage or under hot conditions.

Additional information

Butisan S has been widely used in trials on field-grown nursery stock and in commercial practice. It gives useful control of a wide range of weeds including annual grasses, groundsel and willowherb, and it has been widely used for Canadian fleabane and simazine resistant groundsel control. However, it can be of relatively short persistence, lasting around three months and label restrictions on permitted applications within 3 years on the same field will be a limitation to use. It appears non-phytotoxic to newly planted stock, but has a slight contact action. This is useful in controlling seedling weeds but can cause problems when it is applied over crop foliage. Label states that application should not be made to soft, vigorously growing foliage, particularly during or after a period of warm days and cold nights.

Experimental information

Butisan S has been used in trials in mixtures with Flexidor 125 or Stomp Aqua although there are no specific label recommendations for these mixtures in nursery stock. Tank mixtures may be used off-label at grower's own risk providing all the conditions of both labels can be complied with. A small area of the crop should be tested first for adverse effects before treating the whole crop.

Devrinol

Active ingredient

Napropamide (450g/litre).

Formulation

Suspension concentrate.

Supplier

United Phosphorus Ltd.

Mode of action

Residual, soil acting.

Label recommendations

Field-grown trees and shrubs.

Rates of use

9.0 litres/ha (in 200-1,000 litres of water/ha).

Timing

November to end of February. March and April with 25mm irrigation after application.

Label use restrictions

Soil should be firm around roots before application. Plants with poor vigour or shallow roots should not be treated. Yellow and gold varieties of conifers and alpines should not be treated. Do not treat crops affected by poor soil, adverse weather or cultural conditions. Should not be used on sands or soils with more than 10% organic matter. Surface manure, straw, trash, moss or other organic material may reduce weed control. Soil cultivations after spraying should be avoided. Residual activity may cause losses in following crops.

Additional information

Effective against a wide range of weeds, particularly useful against groundsel, but provides only poor control of cruciferous weeds such as charlock. Timing restrictions are due to possible photo-degradation, which normally limits the application of this herbicide to winter months. Application can be made in March and April if 25mm irrigation is applied after application. A wide range of trees and shrubs have been treated (although these are not specified on the label) and apart from gold and yellow conifers and container-grown alpines, no phytotoxicity has been noted.

Finale

Active ingredient

Glufosinate-ammonium (120g/litre).

Formulation

Soluble concentrate.

Supplier

Bayer Environmental Science.

Mode of action

Non-selective contact.

Label recommendations

Non-edible crops.

Rates of use

5.0-8.0 litres/ha (in 200-500 litres of water/ha).

Timing

Apply between 1 March and 30 September when weeds are growing actively.

Label use restrictions

Do not spray wet foliage or if rain is likely within six hours. Crops can normally be planted immediately after spraying but on sand, very light or immature peat soils, allow at least three days before planting. A maximum of two treatments can be made per year.

Additional information

For control of emerged weeds in woody nursery stock, apply as a directed spray avoiding dormant or green buds, suckers, damaged or green bark and any crop foliage. Also for use pre-planting. Slower acting than diquat formulations but better control of small nettle and willowherb and more persistent control of perennial weeds. No residual action.

Finalsan Plus

Active ingredient

Pelargonic acid 186.7g/litre + maleic hydrazide 30g/litre.

Formulation

Soluble concentrate.

Supplier

Certis.

Mode of action

Non-selective contact.

Label recommendations

Ornamental plant production (around woody plants and trees). Amenity vegetation. Natural surfaces not intended to bear vegetation, permeable surfaces overlying soil.

Rates of use

166 litres/ha (in 1,000 litres of water/ha).

Timing

Apply during vegetation period.

Label use restrictions

Do not direct spray or allow spray drift onto cultivated plants as Finalsan Plus destroys all green plant parts. Therefore, a spray shield should be used for application in order to protect vulnerable foliage. Do not use Finalsan Plus against mosses or weeds in grass.

Additional information

Finalsan Plus is a herbicide with foliar activity against a broad range of weeds. Algae and mosses in open spaces around trees will usually be controlled by a single application. Good spray cover of the algae, mosses and weeds is essential. Finalsan Plus is most effective against small actively growing weeds. Weeds must be dry before application. Finalsan Plus does not have a long-term effect and re-emergence of affected weeds may occur. Therefore a repeat application may be required after 30-60 days. Algae and mosses in open spaces around trees will usually be controlled by a single application but repeat application may be applied after 30-60 days if incomplete control is achieved or following re-growth.

Flexidor 125

Active ingredient

Isoxaben (125g/litre).

Formulation

Suspension concentrate.

Supplier

Landseer.

Mode of action

Residual, soil acting.

Label recommendations

Field-grown hardy ornamental nursery stock.

Rates of use

2.0 litres/ha (in 200-500 litres of water/ha).

Timing

No restriction, after planting or on established plantings.

Label use restrictions

Maximum of two applications per annum. Soil should be moist and free of clods and emerged weeds at application. Residual activity may influence husbandry prior to the next crop in the rotation.

Additional information

Flexidor 125 gives good control of a range of important nursery stock weeds, including crucifers and polygonums. Control of annual meadow-grass, cleavers, groundsel and willowherb is less effective so it is important to use in a programme or tank mixture with other herbicides where these weeds are expected. Persistence is good providing the herbicide has been washed in well by rainfall or irrigation.

Experimental information

In trials it has been used on a wide range of hardy nursery stock, including newly planted crops with few cases of damage reported.

There is some potential for use on field-grown herbaceous stock, but note that a number of species can be damaged (see Table 13). This is an off-label use at the grower's own risk.

Intruder

Active ingredient

Chlorpropham (400g/litre).

Formulation

Emulsifiable concentrate.

Supplier

Agrichem BV.

Mode of action

Residual, soil acting, with some contact action.

Label recommendations

Ornamental plant production.

Rates of use

2.0 litres/ha (in 330–660 litres of water/ha).

Timing

Not specified for nursery stock.

Label use restrictions

Not specified for nursery stock. Apply to freshly cultivated soil. Adequate rainfall must occur after spraying. Activity is greater in cold, wet conditions than in warm, dry conditions. Excess rainfall after application may result in crop damage. Do not apply to sands, very light soils or soils low in organic mattter.

Additional information

Chlorpropham is not widely used on nursery stock crops but it is included in this section because similar formulations were used in HDC trials on tree seed beds, other formulations of chlorpropham have different active ingredient concentrations. Chlorpropham has good contact action against chickweed but cleavers, groundsel, mayweed and sow-thistle are not controlled. It has limited residual life in the soil especially under warm weather conditions. It can be useful for the control of knotgrass and weed seedlings that germinate in autumn or winter.

Experimental information

In HDC project HNS 31 on tree seed beds, chlorpropham was not damaging to the trees species tested. However, because of the limited weed spectrum and short residual life, the weed control was not as good as that from other products used in the trial.

Reglone

Active ingredient

Diquat (200g/litre).

Formulation

Soluble concentrate.

Supplier

Syngenta Crop Protection UK Ltd.

Mode of action

Non-selective contact.

Label recommendations

Hardy or woody ornamentals.

Rates of use

2.0 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on the label.

Label use restrictions

For use around crops, non cropped areas and pre-planting. On sandy or immature peat soils allow three days between spraying and planting.

Additional information

Reglone can be used for the control of emerged weeds in woody nursery stock apply as a directed spray avoiding green bark and any crop foliage. It is also used pre-planting.

Most annual weeds are controlled, but cleavers, grasses, knotgrass and small nettle become more resistant beyond the seedling stage. The top growth of perennial weeds is controlled but re-growth will occur as diquat is not translocated to the root system. More persistent results can be obtained by spraying under dull conditions.

Ronstar Liquid

Active ingredient

Oxadiazon (250g/litre).

Formulation

Emulsifiable concentrate.

Supplier

Certis.

Mode of action

Pre-emergence residual with contact action.

Label recommendations

Ornamental trees and shrubs.

Rates of use

4.0-8.0 litres/ha (in 300-1,000 litres of water/ha).

Timing

January to June.

Label use restrictions

Avoid spraying young leaves or shoots. Pre-emergence activity is reduced where the soil organic matter content is more than 10%. Do not cultivate the soil after treatment.

Additional information

Ronstar Liquid controls a very wide weed spectrum including all the simazine resistant weeds, cleavers, groundsel, knotgrass, and willowherb.

The contact action of Ronstar Liquid means that during the growing season it cannot be applied over foliage. Care should be taken to avoid spraying over crops at bud burst or later. However, it can be used as a directed spray to the soil, avoiding young leaves and shoots. As there is no root absorption crop safety is very good providing these precautions are taken, although occasionally there is minor scorch of lower leaves from soil splash. Use on dormant newly planted stock is permitted.

Experimental information

The product has generally performed well, when compared with other herbicides in HDC projects (HNS 31 and HNS 78). The main weeds not controlled are chickweed and pearlwort. These can be covered by adding a low rate of Flexidor 125 within the herbicide programme.

Shield 400 (Dow)

Active ingredient

Clopyralid (400g/litre).

Formulation

Soluble concentrate.

Supplier

Dow AgroSciences Ltd.

Mode of action

Selective contact.

Label recommendations

Ornamental trees and shrubs.

Rates of use

0.5 litre/ha (in 200 litres of water/ha).

Timing

When thistle is at rosette stage up to 30cm across.

Label use restrictions

Maximum total dose 1 litre/ha per year. See label for susceptible species.

Additional information

A contact herbicide used primarily for the control of thistles, and other mayweeds in nursery stock crops. It can be applied as a directed spray but all spray or drift contact with leaves, buds, suckers, or green stem of the crop must be avoided. Should not be applied within the root zone of species of the family *Compositae* (*Asteraceae*) such as *Senecio* or *Papilionaceae* including species of *Cytisus, Genista* and *Laburnum*. When spot treating take care not to overdose as root uptake by the crop is possible, particularly when actively growing as in the maiden year of tree and rose production.

Herbicides without label recommendations

Herbicides without label recommendations

The information in this section is based on results of HDC trials and commercial practice. There are no label recommendations for the use of these products on nursery stock. However, usage on nursery stock crops is permitted off-label via an Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU) or under the Long Term Arrangements for Extension of Use (LTAEU) but any such usage by growers is entirely at their own risk.

These profiles are presented in alphabetical order of the typical product.

Other registered products with the same active ingredient as the typical products above are listed at the end of the section.

Always read the product label, use pesticides safely.

Aramo

Active ingredient

Tepraloxydim (50g/litre).

Formulation

Emulsifiable concentrate.

Supplier

BASF plc.

Mode of action

Selective, post-emergence translocated.

Approval status

EAMU 2313/08.

Rates of use

1.0 – 1.5 litres/ha (in 100-200 litres of water/ha).

Timing

No specific restriction, but treatment should be carried out when grass weeds are growing actively. Treatment under cold conditions or in dry soil conditions will give slower activity.

Label use restrictions

Not specified for nursery stock. Maximum of one application per year.

Additional information

Aramo is one of a number of grass herbicides that can be used selectively in broad-leaved crops to control a range of annual and perennial grass weeds. Aramo will control annual meadow-grass, which is resistant to many other selective grass herbicides. Aramo is registered for use on ornamentals in some states of the US, and is being used on ornamentals in continental Europe. At present in the UK the product label only covers use on broadleaved arable and vegetable crops. There is little experimental work on the use of Aramo on ornamentals in the UK, but commercial experience to date has been encouraging.

Artist

Active ingredient

Flufenacet (24% w/w) + metribuzin (17.5% w/w).

Formulation

Wettable powder.

Supplier

Bayer CropScience Ltd.

Mode of action

Pre-emergence, residual with contact action.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

2.5kg/ha (in at least 200 litres of water/ha).

Timing

No restriction.

Label use restrictions

One application per year.

Additional information

Artist is a pre-emergence residual herbicide with moderate contact action on emerged weeds or crop. It should not be applied over crop foliage but can be used as a directed spray between crop rows or over dormant stock. A good range of grasses and broad-leaved weeds are controlled. Some important weeds of field-grown nursery stock are controlled including chickweeds, fat-hen, groundsel, knotgrass, orache and willowherb, however black bindweed, black nightshade and cleavers are only partially controlled. Its main use in nursery stock is likely to be as a medium-term spring and summer herbicide particularly in programmes or mixtures with Stomp Aqua or Ronstar Liquid where improved control of groundsel and willowherb is required.

Experimental information

Artist was tested on a range of rose cultivars in HDC project HNS 132 as a post-planting and post-heading back treatment and was found to be safe on all cultivars tested. Where it was used over the foliage of broad-leaved trees it was damaging, but was safe when used as a directed spray between crop rows (HDC project HNS 139). Only a limited number of tree species have been tested in the UK to date and Artist should be used with some caution until further information is known.

Betanal Flow

Active ingredient

Phenmedipham (160g/litre).

Formulation

Suspo-emulsion.

Supplier

Bayer CropScience Ltd.

Mode of action

Selective, contact action.

Approval status

EAMU 2824/08.

Rates of use

2.5 litres/ha (in 80-100 litres of water/ha).

Timing

No restriction.

Label use restrictions

No more than 6 litres/ha total application per crop.

Additional information

Betanal Flow is a contact herbicide with action on small seedling weeds. It is generally used in repeated low dose applications starting when the weeds have reached cotyledon stage. A good range of broad-leaved weeds are controlled but black nightshade, grasses and mayweed are not well controlled. Polygonums such as knotgrass and redshank can be controlled under favourable conditions. The addition of Dow Shield 400 improves control of these weeds but may not be tolerated by some crops. The recommended water volume should not be exceeded otherwise crystallization can occur. Nozzles designed to give a fine spray quality should always be used.

Experimental information

Betanal Flow has not been widely tested on nursery stock but is often used by growers of herbaceous crops and in rose stocks. Single applications were tested in tree seed beds (HDC project HNS 155) and were found to be safe to selected species when applied at the four true leaf crop stage (Table 14). Tree growers have used Betanal Flow to control small seedling weeds where residual herbicides have failed. However there is little information on crop safety and some temporary leaf yellowing may occur if it is applied over the crop foliage.

Centium 360 CS

Active ingredient

Clomazone (360g/litre).

Formulation

Capsule suspension.

Supplier

Belchim Crop Protection Ltd.

Mode of action

Selective, pre-emergence, residual.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

0.25 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction.

Label use restrictions

One application per crop.

Additional information

Centium 360 CS is a pre-emergence residual herbicide with some contact action on emerged weeds or crop. It has a limited weed control spectrum and is therefore generally used as a tank mix partner, for example with Stomp Aqua, where improved control of cleavers, groundsel and mayweed is required. It causes marked leaf bleaching if applied over crop foliage in active growth or to breaking buds. Heavy rainfall after application can also lead to leaf bleaching through root uptake although this is often temporary. Its main use is likely to be as a residual pre-emergence herbicide in tree seed beds although it could also be used in field-grown trees if applied during the dormant season.

Experimental information

Centium 360 CS was tested at reduced rates as a residual herbicide in tree seed beds (HNS 155) and was found to be safe to a selected range of plant species (Table 14). There is a risk of leaf bleaching if used on light soils particularly if heavy rain falls after application. This effect is normally temporary although some incidences of damage have been reported.

Dual Gold

Active ingredient

S-metolachlor (960g/litre).

Formulation

Suspension concentrate.

Supplier

Syngenta Crop Protection UK Ltd.

Mode of action

Selective, pre-emergence, residual.

Approval status

EAMU 0501/12.

Rates of use

0.78 litre/ha (in 200 litres of water/ha).

Timing

1 May–31 May.

Label use restrictions

One application per crop.

Additional information

Dual Gold is a pre-emergence residual herbicide with very little contact action on emerged weeds or crops. A good range of grasses including annual meadow-grass are controlled together with a more limited range of broad-leaved weeds. Some important weeds of field-grown nursery stock are controlled including chickweeds, groundsel, sow-thistle and willowherb, however polygonums are not well controlled. Its main use in nursery stock is likely to be as a short-term early summer herbicide particularly in programmes or mixtures with Flexidor 125 or Venzar Flowable where improved control of grasses, groundsel, speedwell and willowherb is required and application over crop foliage is necessary. A similar formulation to Dual Gold has been available in the US for use on field-grown nursery stock and crop safety information is included in Tables 11, 12 and 13. Note that the US label advises irrigation after application to avoid foliar damage.

Experimental information

Dual Gold was tested on a range of hardy nursery stock in HDC projects HNS 139 and HNS 139a as a summer treatment and was found to be safe on the majority of broad-leaved and evergreen shrub species tested. Results of the crop safety tests are shown in Table 2. Further trials were carried out to assess safety on a wide range of herbaceous subjects (HNS 166) and results are encouraging with only *Campanula, Delphinium, Echinacea, Leucanthemum, Monarda, Rudbeckia* and *Stachys* showing sensitivity. Dual Gold was found to be safe to use on a limited range of tree species when used as a pre-emergence herbicide in seed bed trials (HNS 155).

Only a limited number of species have been tested in the UK to date and Dual Gold should be used with some caution until further information is known.

Goltix WG

Active ingredient

Metamitron (70% w/w).

Formulation

Wettable powder.

Supplier

Makhteshim Agan (UK) Ltd.

Mode of action

Contact with limited residual action, soil acting.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

3.0kg/ha (in 200 litres of water/ha).

Timing

Not specified for nursery stock. Post emergence of weeds.

Label use restrictions

Not specified for nursery stock. Maximum of three treatments at the full rate.

Additional information

Metamitron is used for the control of small dicotolydon seedling weeds up to the two– leaf stage. It is not generally used in the UK as a herbicide in hardy nursery stock production, although it is used in Germany on tree seed beds. Goltix WG was tested in HDC herbicide trials on tree seed beds. It has also been used as a selective contact herbicide in field-grown herbaceous nursery stock production.

Experimental information

Goltix WG was tested at a low application rate (3kg/ha) in HDC projects HNS 31 and HNS 155 as a contact and residual herbicide. Although many species were unaffected *Betula, Cotoneaster* and *Sorbus* were damaged.

Laser

Active ingredient

Cycloxydim (200g/litre).

Formulation

Emulsifiable concentrate.

Supplier

BASF plc.

Mode of action

Selective, post-emergence, translocated.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

Annual grasses: 0.5-0.75 litres/ha (in 100-330 litres of water/ha).

Perennial grasses: 2.25 litres/ha (in 100-330 litres of water/ha).

An approved adjuvant oil must be added at 0.8% spray volume.

Timing

Treatment must only be carried out when grass weeds are growing actively. Treatment under cold conditions or in dry soil conditions will give rise to slower activity.

Label use restrictions

Maximum of one treatment per year. For maximum effect on couch grass, do not cultivate for at least two weeks after treatment.

Additional information

Use of Laser is off-label under the Long Term Arrangements for Extension of Use and is at grower's own risk. Laser is one of a number of grass herbicides that can be used selectively in broad-leaved crops. There should be good tolerance within a range of broad-leaved ornamentals.

Roundup (Pro Biactive)

Active ingredient

Glyphosate (360g/litre).

Formulation

Soluble concentrate.

Supplier

Monsanto (UK) Ltd.

Mode of action

Non-selective, contact, translocated.

Approval status

EAMU 2877/08.

Rates of use

5.0 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction but weeds should be actively growing.

Label use restrictions

Maximum normally one application per crop or season. Do not spray suckers in late summer or autumn.

Additional information

Used for the control of annual and perennial weeds in woody ornamentals (trees and shrubs). Must be used as a directed spray with great care. As the product is translocated, even a small amount of drift onto crop foliage can cause lasting damage. It can also be used for weed control pre-planting. There is no residual activity.

Late summer applications are most effective for weed control.

Shark

Active ingredient

Carfentrazone-ethyl (60g/litre).

Formulation

Microemulsion.

Supplier

Belchim Crop Protection Ltd.

Mode of action

Non selective contact.

Approval status

EAMU 2552/08.

Rates of use

0.33-0.8 litres/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on EAMU.

Label use restrictions

For use around crops or non-cropped areas. Maxmium of 1.6 litres/ha per crop.

Additional information

For control of emerged weeds in non-cropped areas or around crops when applied as a directed spray avoiding any crop foliage. It can also be used as a pre-planting treatment. Most annual broad-leaved weeds are controlled when small, but chickweeds, grasses, groundsel and mayweed are not well controlled. The top growth of some perennial weeds can be scorched but re-growth will occur, as Shark is not translocated to the root system. A tank mixture of Shark with Harvest gives improved control of cleavers, crane's-bill and willowherb.

Springbok

Active ingredient

Dimethenamid-p (200g/litre) + metazachlor (200g/litre).

Formulation

Emulsifiable concentrate.

Supplier

BASF plc.

Mode of action

Pre-emergence, residual with slight contact action.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

1.66-2.5 litres/ha (in at least 220 litres of water/ha).

Timing

No restriction.

Label use restrictions

Applications are limited to a total dose of not more than 5 litres/ha in a three year period on the same field. This is equivalent to 1.66 litres/ha per year.

Additional information

Springbok is a pre-emergence residual herbicide with slight contact action on emerged weeds or crops. It should not be applied over soft, vigorously growing crop foliage but can be used as a directed spray between crop rows or over dormant stock. A good range of grasses and broad-leaved weeds are controlled. The weed control spectrum is similar to that of Butisan S but offers improved control of cleavers, crane's-bill, poppy and small nettle. As with Butisan S, persistence will be around three months.

Experimental information

Springbok was tested on *Prunus* 'Colt' in HDC project HNS 139 as a summer treatment applied over the foliage. The growing point was hardened and slightly distorted but the trees grew away after treatment. Springbok was found to be safe to use on a limited range of tree species when used as a pre-emergence herbicide in seed bed trials (HNS 155).

Stomp Aqua

Active ingredient

Pendimethalin (400g/l).

Formulation

Suspension concentrate.

Supplier

BASF plc.

Mode of action

Residual, soil acting.

Approval status

EAMU 2923/08.

Rates of use

2.9 litres/ha (in 100-200 litres of water/ha).

Timing

Dormant season unless directed spray.

Label use restrictions

Not specified for nursery stock.

Additional information

Pendimethalin has never had a label recommendation for field-grown nursery stock in the UK, although it has recommendations in other countries and is occasionally used by UK growers under EAMU. Its main use is for general weed control including polygonums such as knotgrass which are resistant to many herbicides. Unfortunately there is no control of groundsel and poor control of other *Compositae* weeds such as mayweed and sow-thistle. Off-label uses are at the grower's own risk. An early spring application of pendimethalin can be expected to give four to six months weed control.

Experimental information

There is little published information about crop tolerance available, although Stomp Aqua has been used without damage on roses and a range of trees in HDC projects HNS 31, HNS 78, HNS 155 and MAFF/ADAS trials. Stomp Aqua would normally be applied during the dormant season to deciduous trees and conifers, as application over growing tips can cause temporary scorch and stunting; mature deciduous leaves are less liable to damage. Winter application of Stomp Aqua is reported to have caused stem splitting on *Crataegus.* Stomp Aqua has proved to be relatively safe at lower rates as a residual herbicide for tree seed beds, see Table 14.

Sumimax

Active ingredient

Flumioxazine (300g/litre).

Formulation

Suspension concentrate.

Supplier

Interfarm (UK) Ltd.

Mode of action

Selective, pre-emergence residual with contact action.

Approval status

EAMU 2881/08.

Rates of use

0.1 litre/ha (in 200-400 litres of water/ha).

Timing

No restriction specified on the label but due to strong contact action it is only likely to be safe on fully dormant crops.

Label use restrictions

One application per crop.

Additional information

Similar products Digital (EAMU 2844/08) and Guillotine (EAMU 2897/08) also have off-label approval for use in ornamental plant production. Sumimax is a pre-emergence residual herbicide with strong contact action on emerged weeds via root uptake and foliar action. A good range of broad-leaved weeds are controlled but grasses are more resistant. Some important weeds of field-grown nursery stock are controlled including black nightshade, chickweeds, fat-hen, groundsel, sow-thistle and willowherb. As Sumimax has a strong contact action it will be damaging to broad-leaved deciduous crops when in leaf or to evergreens where the leaf is not sufficiently hardened.

Products that are similar to Sumimax have been used in the US on nursery stock but normally only as winter treatments on established crops.

Experimental information

Sumimax was tested as a post-planting spray on dormant rose stocks (HDC project HNS 155) before leafing out. Although it was safe, weed control from late spring treatments of Sumimax have been disappointing possibly due to dry soil conditions. The product appears to work better as a winter or early spring herbicide where a range of existing weed is controlled and residual control extends into the spring.

Timbrel

Active ingredient

Triclopyr (480g/litre).

Formulation

Emulsifiable concentrate.

Supplier

Dow AgroSciences Ltd.

Mode of action

Contact, translocated.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

Up to 8.0 litres/ha (in 200– 300 litres of water/ha).

Timing

Not specified for nursery stock.

Label use restrictions

Not specified for nursery stock. Allow a minimum interval between application and planting of six weeks.

Additional information

These products are often used for control of broad-leaved perennial weeds and woody scrub in non-cropped areas around fields or as a pre-planting treatment for certain difficult to control weeds such as perennial nettles. These products can be volatile, so should never be used within crops as spot treatments. Great care should be taken to avoid drift onto crops.

Venzar Flowable

Active ingredient

Lenacil (440g/litre).

Formulation

Soluble concentrate.

Supplier

Du Pont Ltd.

Mode of action

Residual, soil acting.

Approval status

Long Term Arrangements for Extension of Use.

Rates of use

Up to 5.0 litres/ha (in 200-500 litres of water/ha).

Timing

Not specified for nursery stock.

Label use restrictions

Not specified for nursery stock.

Additional information

For many years Venzar WP had a label for use on field-grown nursery stock including herbaceous and flower crops. This label was withdrawn when the product was replaced with a flowable formulation. Long Term Arrangements for Extension of Use at the grower's own risk are available for Venzar Flowable.

Experimental information

This herbicide is now mainly used on field-grown herbaceous crops and occasionally on field-grown trees for particular weed problems such as knotgrass and orache. The weed spectrum misses a few important weeds such as cleavers, groundsel and speedwells and it can be very unreliable under dry conditions. Conversely damage through root uptake can occur when heavy rain follows application and results in severe damage.

Information about crop tolerance is available but soil conditions and rainfall are a major factor (Tables 11-14). Most information is based on the WP formulation however, there is some anecdotal evidence that there is slightly more risk of damage from the flowable formulation.

Other registered products with the same active ingredient as the typical products

Herbicides with label recommendations

Typical product	Active ingredient
Butisan S	**Metazachlor**
Other products registered	**Approval holder**
Agrotech Metazachlor 500 SC	Agrotech Trading GmbH
Alpha Metazachlor 50 SC	Makhteshim-Agan (UK) Ltd
Butey	Chem-Wise Ltd
Clayton Buzz	Clayton Plant Protection (UK) Ltd
Clayton Metazachlor 50 SC	Clayton Plant Protection (UK) Ltd
EA Metazachlor	European Agrochemicals Ltd
Fuego 50	Makhteshim-Agan (UK) Ltd
Greencrop Monogram	Greencrop Technology Ltd
Makila 500 SC	Novastar Link Ltd
Marksman	AgriGuard Ltd
Mashona	AgChemAccess Ltd
Metachlor	Euro Chemicals s.r.o
Metaz 50	RouteOne Products Ltd
Metazachlore GL 500	Globachem NV
Mezzanine	AgriGuard Ltd
Rhapsan 500 SC	Nufarm UK Ltd
Route One Metaz 50	Albaugh UK Ltd
Standon Metazachlor 500	Standon Chemicals Ltd
Sultan 50 SC	Makhteshim-Agan (UK) Ltd

Typical product	Active ingredient
Devrinol	**Napropamide**
Other products registered	**Approval holder**
Associate	FMC Chemical Sprl
Banweed	United Phosphorous Ltd
Jouster	Agriguard Ltd
MAC Napropamide 450 SC	MAC-GmbH
Nappa	Chemsource Ltd
Naprop	Globachem NV

Typical product	Active ingredient
Finale	**Glufosinate–ammonium**
Other products registered	**Approval holder**
Basta	Bayer CropScience Ltd
Challenge	Bayer CropScience Ltd
Challenge 60	Bayer CropScience Ltd
Finale	Bayer Environmental Science
Finale 150	Bayer Environmental Science
Kaspar	Certis
Kibosh	AgChemAccess Ltd
KurTail	Progreen Weed Control Solutions Ltd
PureReep	Pure Amenity Ltd
Weedex	Novastar Link Ltd

Typical product	Active ingredient
Flexidor 125	**Isoxaben**
Other products registered	**Approval holder**
Agriguard Isoxaben	Agriguard Ltd
Flexidor	Dow AgroSciences Ltd
Gallery 125	Rigby Taylor Ltd

Typical product	Active ingredient
Reglone	**Diquat**
Other products registered	**Approval holder**
Various	Various

Typical product	Active ingredient
Ronstar Liquid	**Oxadiazon**
Other products registered	**Approval holder**
Clayton Oxen FL	Clayton Plant Protection (UK) Ltd
Festival	Bayer Environmental Science
Noble oxadiazon	Barclay Chemicals (R & D) Ltd
Standon Roxx L	Standon Chemicals Ltd

Typical product	Active ingredient
Shield 400 (Dow)	**Clopyralid**
Other products registered	**Approval holder**
Cliophar	Agriphar S.A
Cliophar 400	Agriphar S.A
Dow Shield	Dow AgroSciences Ltd
Glopyr 400	Globachem NV
Lontrel 200	Dow AgroSciences Ltd
Lontrel 72 SG	Dow AgroSciences Ltd
Shield SG	Dow AgroSciences Ltd
Vivendi 200	Agrichem BV

Herbicides without label recommendations

Typical product	Active ingredient
Centium 360 CS	**Clomazone**
Other products registered	**Approval holder**
Cirrus CS	Belchim Crop Protection Ltd
Clayton Chrome	Clayton Plant Protection (UK) Ltd
Clayton Surat	Clayton Plant Protection (UK) Ltd
Clomate	Albaugh Europe SARL
Clomaz 36 CS	Goldengrass Ltd
Clone	AgriGuard Ltd
Concept	Chemsource Ltd
Echo	AgriGuard Ltd
Fiddle	Goldengrass Ltd
Gadwall	AgChemAccess Ltd
Gamit 36 CS	Belchim Crop Protection Ltd
IT Clomazone	Inter-Trade Aalborg A/S
Mazone 360	Euro Chemicals s.r.o
Pan Fillip	Pan Agriculture Ltd

Typical product	Active ingredient
Goltix WG	**Metamitron**
Other products registered	**Approval holder**
Alpha Metamitron	Makhteshim-Agan (UK) Ltd
Alpha Metamitron 70 SC	Makhteshim-Agan (UK) Ltd

Typical product	Active ingredient
Bettix Flo	United Phosphorus Ltd
Bettix WG	United Phosphorus Ltd
Celmitron 70% WDG	Agrichem BV
Defiant SC	United Phosphorus Ltd
Defiant WG	United Phosphorus Ltd
Goldbeet	Makhteshim-Agan (UK) Ltd
Goltix 90	Makhteshim-Agan (UK) Ltd
Goltix Compact	Aako BV
Goltix Flowable	Makhteshim-Agan (UK) Ltd
Hockley Metamitron 70	Hockley International Ltd
Homer	Makhteshim-Agan (UK) Ltd
IT Metamitron SC	IT Agro Ltd
Lektan	Makhteshim-Agan (UK) Ltd
Marquise	Makhteshim-Agan (UK) Ltd
Meta WDG	ChemSource Ltd
Mitron 70 WG	Hermoo Belgium NV
Mitron 700	Euro Chemicals s.r.o
Mitron 90 WG	Hermoo Belgium NV
Mitron SC	Hermoo Belgium NV
Predator WG	Agriguard Ltd
Skater	Makhteshim-Agan (UK) Ltd
Target SC	Agrichem BV

Typical product	Active ingredient
Roundup Pro Biactive	**Glyphosate**
Other products registered	**Approval holder**
Various	Various

Typical product	Active ingredient
Springbok	**Dimethenamid-p + metazachlor**
Other products registered	**Approval holder**
Muntjac	BASF plc

Typical product	Active ingredient
Stomp Aqua	**Pendimethalin**
Other products registered	**Approval holder**
Aquarius	Makhteshim-Agan (UK) Ltd
Cinder	Makhteshim-Agan (UK) Ltd
PDM 330 EC	BASF plc
Stomp 400 SC	BASF

Typical product	Active ingredient
Sumimax	**Flumioxazine**
Other products registered	**Approval holder**
Digital	Interfarm (UK) Ltd
Guillotine	Interfarm UK Ltd

Typical product	Active ingredient
Timbrel	**Triclopyr**
Other products registered	**Approval holder**
Altix 240 EC	Agriphar S.A
Cleancrop Triptic 48 EC	United Agri Products
Cleancrop Unival	United Agri Products
Clopyr 480	Euro Chemicals s.r.o
Garlon 4	Dow AgroSciences Ltd
Nomix Garlon 4	Nomix Enviro,
PureWoody	Pure Amenity Ltd
Thrash	Pan Agriculture Ltd
Woody	AgChemAccess Ltd

Typical product	Active ingredient
Venzar Flowable	**Lenacil**
Other products registered	**Approval holder**
Agriguard Lenacil	Tronsan Ltd
Fernpath Lenzo Flo	Agriguard Ltd
Lenazar Flow	Hermoo Belgium NV
Venzar 80 WP	Du Pont (UK) Ltd

The addresses and contact details for the suppliers listed in this section can be found in Appendix 6.

Section 4: **Specific crop guidelines**

Specific crop guidelines

Trees and shrubs

Pre-planting preparations

Nursery stock crops such as standard trees are long term investments so it is essential to ensure that the land is free from weeds, particularly perennials, before planting is undertaken. Good husbandry cultivations, combined with the careful and responsible use of herbicides, will achieve this.

On weedy sites, a fallow period of at least one growing season is advisable to allow sufficient time to bring weed populations under control. This should be allowed for in crop rotations. Cultivations can be, and are, used to control many annual weeds and will, if repeated, control some of the shallow-rooted perennials such as buttercup. Deep-rooted perennial weeds are however unlikely to respond to this and will require treatment with herbicides to avoid them re-growing. Ideally, a structured programme should be adopted which combines non-chemical/cultural control with the targetted use of herbicides. Soil sterilisation is also an option for outdoor seed beds and herbicide sensitive crops. Clean planting stock is essential to avoid the transfer of weed problems and will help reduce the need to use herbicides during the timeframe of the crop.

Cultivations to control background weeds amongst headlands and surrounding land will also reduce weed pressure and herbicide use. Soil conditioners and bulky organic manures incorporated pre-planting should also be free from perennial weeds.

Pre-planting herbicide options

Normally, glyphosate formulations are used, but there are other alternatives for particularly difficult weeds such as creeping yellow-cress and horsetail. In HDC project HNS 139, Timbrel was particularly effective for the control of creeping yellow-cress. For horsetail useful control can be achieved with a Finalsan Plus and glufosinate-ammonium tank mix (see Table 7). Herbicides for the control of annual weeds which germinate between final cultivations and planting, can be applied just prior to planting.

Post-planting herbicide options

Following planting a residual herbicide should normally be applied before weed germination takes place. Although newly planted stock can be susceptible to herbicide damage particularly on light soils, there are a number of herbicides that can be used after planting with minimum phytotoxicity and have recommendations for such use (Table 7).

Ronstar Liquid, and combinations of Butisan S, Flexidor 125 and Stomp Aqua have generally given good results in HDC projects (HNS 31 and HNS 78) when applied after planting, and can be used on a wide range of species (Table 11). As a result of the contact action of Ronstar Liquid, application should not be made after bud burst. Ronstar Liquid does not control chickweed so where this is likely to be a problem, another herbicide such as Butisan S, Flexidor 125 or Stomp Aqua should be added within the programme.

Other post-planting non-chemical options

Non-chemical weed control, embracing mulches and permeable ground cover materials, is a viable option for herbicide sensitive crops such as stock plants, heathers and herbs. This also applies to situations where the use of persistant residual herbicides may not be desirable from an environmental or customer perspective.

Such techniques also reduce evaporation of water from the soil surface and so help to conserve moisture.

Summer top-up herbicide options

Most herbicides applied after planting will not have the persistence to cover autumn weed germination. A further application of herbicide should therefore be made after budding (or equivalent timing on non-budded stock and shrubs). Herbicides such as Venzar Flowable have minimal contact action and so are suitable for application over foliage. If weeds have already started to germinate, these should be removed first by a light cultivation or a spray of diquat carefully directed to the alleyways only. Use a fully enclosed, hooded sprayer to achieve this. Dry field conditions in summer are likely to compromise the efficacy of residual herbicides, so routine cultivations, hand weeding and hoeing may be preferred when sustained dry periods prevail.

Winter and spring herbicide options

The next herbicide treatment should be made in early spring (after heading back on budded trees). As the crop is now established and whilst buds are dormant there is a wider range of herbicides available, (Table 8). Choice will be made according to crop tolerance (Tables 11 and 12) and weed control spectrum (Table 8). Typical herbicide programmes would be based around Butisan S, Flexidor 125, Ronstar Liquid and Stomp Aqua. The use of Stomp Aqua is permitted under an EAMU at growers' own risk.

Sumimax can be used during the winter, particularly for broad-leaf weed control. Although Ronstar Liquid and Sumimax have activity against emerged annual weeds (and Ronstar Liquid additionally against bindweed) it may be necessary to clean off existing weed between or before making applications of the residual herbicides. A range of contact and translocated herbicides may be used as directed sprays (see Table 9) avoiding contact with crop foliage and green stems. Alternatively light cultivations may be made.

Control of perennial weeds in the crop

Where perennial weeds have emerged there are relatively few options available. If there is sufficient space for directed sprays to be used safely, glyphosate could be used for control of a range of perennial weeds, or Dow Shield 400 specifically for thistles. Perennial weeds within the crop row are more difficult to control because of the lack of selective herbicides. However perennial grasses can be controlled within the crop row using selective grass herbicides.

Table 11. Tolerance of field-grown broad-leaved trees and shrubs to herbicides

Crop / Herbicide product	Butisan S[1]	Devrinol[2]	Dual Gold[3]	Flexidor 125[4]	Ronstar Liquid[5]	Sumimax[6]	Venzar Flowable[7]
Approval status	**A**	**A**	**EAMU**	**A**	**A**	**EAMU**	**LTAEU**
Abelia							
Acer	•			•			
Aesculus	•						
Ailanthus	•						
Alnus	•			•			
Amelanchier	•			•			
Amorpha				•			
Aralia				•			
Arundinaria							
Aucuba				•			
Azalea							
Berberis	•			•			
Betula	•			•			
Buddleia							
Buxus							
Camellia							
Carpinus	•			•			
Caryopteris							
Castanea							
Catalpa							
Ceanothus							
Cercis							
Chaenomeles							
Choisya							
Cistus							
Colutea				•			
Cornus	•						
Corylopsis							
Corylus	•			•			
Cotoneaster	•						
Crataegus	•			•			
Cytisus							
Daphne							
Deutzia				•			
Elaeagnus							

Table 11. Tolerance of field-grown broad-leaved trees and shrubs to herbicides

Crop \ Herbicide product	Butisan S[1]	Devrinol[2]	Dual Gold[3]	Flexidor 125[4]	Ronstar Liquid[5]	Sumimax[6]	Venzar Flowable[7]
Approval status	**A**	**A**	**EAMU**	**A**	**A**	**EAMU**	**LTAEU**
Erica							
Escallonia				•			
Eucalyptus							
Euonymus	•			•			
Exochorda							
Fagus	•			•			
Forsythia	•			•			
Fraxinus	•			•			
Fuchsia							
Gardenia							
Genista							
Gleditsia				•			
Griselinia							
Hamamelis							
Hebe				•			
Hedera							
Hibiscus				•			
Hoheria							
Hydrangea							
Hypericum	•			•			
Ilex							
Jasminum							
Juglans							
Kalmia							
Kerria							
Koelreuteria							
Kolkwitzia							
Laburnum				•			
Lavandula							
Leucothoe							
Ligustrum	•			•			
Liquidamber							
Liriodendron	•						
Lonicera	•						
Magnolia							

Table 11. Tolerance of field-grown broad-leaved trees and shrubs to herbicides

Herbicide product / Crop	Butisan S[1]	Devrinol[2]	Dual Gold[3]	Flexidor 125[4]	Ronstar Liquid[5]	Sumimax[6]	Venzar Flowable[7]
Approval status	**A**	**A**	**EAMU**	**A**	**A**	**EAMU**	**LTAEU**
Mahonia	•						
Malus	•						
Morus							
Nandina							
Nothofagus							
Osmanthus							
Osmarea							
Philadelphus	•			•			
Photinia							
Physocarpus							
Pieris							
Pittosporum							
Platanus	•						
Poncirus							
Populus	•			•			
Potentilla	•			•			
Prunus	•			•			
Pyracantha			•				
Pyrus	•						
Quercus	•			•			
Rhamnus							
Rhododendron							
Rhus							
Ribes	•			•			
Robinia	•			•			
Rosa	•			•			
Rosmarinus							
Rubus	•						
Ruta							
Salix	•			•			
Sambucus							
Santolina							
Senecio							
Skimmia				•			
Sophora	•			•			

Table 11. Tolerance of field-grown broad-leaved trees and shrubs to herbicides

Crop \ Herbicide product	Butisan S[1]	Devrinol[2]	Dual Gold[3]	Flexidor 125[4]	Ronstar Liquid[5]	Sumimax[6]	Venzar Flowable[7]
Approval status	**A**	**A**	**EAMU**	**A**	**A**	**EAMU**	**LTAEU**
Sorbus	•						
Spartium							
Spiraea				•			
Symphoricarpos	•						
Syringa							
Tamarix	•			•			
Tilia	•			•			
Ulex							
Ulmus							
Viburnum	•						
Vinca							
Weigela	•			•			
Wisteria							
Zelkova	•						

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Label approval.

EAMU Off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

• Information derived from companies' own literature.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials on plants prior to full scale treatment.

Information sources

1. Butisan S product label.
2. HDC projects HNS 31, HNS 78, EMRS, MAFF/ADAS trials.
3. Product label for Pennant Magnum (US).
4. Flexidor 125 product label, HDC projects HNS 31, HNS 78.
5. Ronstar Liquid product label, HDC projects HNS 31, HNS 78.
6. Product label for Sureguard (US).
7. Du Pont data sheets (1970s). Weed control handbook vol II Recommendations (1978).

Table 12. Tolerance of field-grown conifers to herbicides

Crop \ Herbicide product	Devrinol[1]	Dual Gold[2]	Flexidor 125[3]	Sumimax[4]	Venzar Flowable[5]
Approval status	**A**	**EAMU**	**A**	**EAMU**	**LTAEU**
Abies					
Cedrus					
Chamaecyparis			•		
Cryptomeria					
x Cupressocyparis			•		
Cupressus					
Ginkgo					
Juniperus			•		
Larix					
Picea					
Pinus			•		
Pseudotsuga					
Taxidium					
Taxus					
Thuja			•		
Tsuga					

Tolerant	Crop damage does not normally occur.

A Label approval.

EAMU Off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

• Information derived from companies' own literature.

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials on plants prior to full scale treatment.

Information sources

1. Former label for Fisons Banweed.
2. Product label for Pennant Magnum (US).
3. Flexidor 125 product label.
4. Product label for Sureguard (US).
5. Du Pont data sheets (1970s). Weed control handbook vol II Recommendations (1978).

Roses

Preparation

The key to successful weed control is thorough preparation before planting. Perennial weeds such as bindweed, couch and thistle must be brought under control well in advance of planting. Where perennial weeds are a serious concern, it is advisable to allow a full growing season for their control. Most roses are grown in rotation on rented farmland. If possible it is beneficial to follow cereal crops where advantage can be taken of the pre-harvest glyphosate treatment to control perennial weeds.

Herbicide options

To maintain acceptable levels of weed control, a programme of residual herbicide treatments is normally used. Typically this will involve one application after planting, followed by applications after budding and heading back in the maiden year. If annual weeds emerge between residual treatments, light cultivations may be used. Contact herbicides based mainly on diquat or glufosinate-ammonium formulations are also popular for spot treating annual weeds and are applied through guarded sprayers.

A range of new residual herbicide programmes for roses were investigated in HDC project HNS 132. After planting options include: Artist, Butisan S, Flexidor 125, Ronstar Liquid and Stomp Aqua. A tank mix of Artist + Stomp 400 SC (now available as Stomp Aqua) was effective and safe to all varieties tested. Following leaf fall in the autumn an application of Sumimax can be made to clean up and maintain weed control through the winter.

To maintain residual control into the spring a further range of herbicides can be used in late winter or following heading back. Artist, Ronstar Liquid and Stomp Aqua are useful options giving a good range of weed control but can be damaging once the shoot growth has started, so use of these herbicides should be confined to the winter months when the buds are fully dormant. Dual Gold and Venzar Flowable have little contact action so, if required, can be used slightly later in early summer.

After post-heading back further residual herbicide treatments during the maiden year are not usually necessary as crop canopies tend to provide natural weed suppression and make effective herbicide penetration difficult. Dry field conditions can compromise the efficacy of summer herbicide applications. Soft maiden growth can also be sensitive to herbicide applications in mid-summer. Spot treatments, hand weeding and inter-row cultivations are widely used.

Control of perennial weeds in the crop

Spot treatments can be used to control established weeds but this must be done carefully to avoid crop damage. Glyphosate is sometimes used for perennial weeds, but roses can be very sensitive so caution is needed.

Where grasses are a problem, selective herbicides such as Aramo can be considered, although none have label recommendations for use in nursery stock. Aramo has an EAMU for use in ornamentals and will control annual meadow-grass. Such use is at growers' own risk.

Herbaceous crops

These crops show less tolerance to the range of herbicides used in woody nursery stock. Since most of them are surface rooting there is little depth protection. There is often a risk of damage from residual herbicides applied to light soils and to soils deficient in organic matter.

Preparation

As a result of the limited range of safe herbicides available both for annual and perennial weed control, every effort should be made to select relatively weed-free fields for planting. As with other nursery crops perennial weeds should be controlled in a fallow or preceeding cereal crop using glyphosate formulations, before planting. Soil sterilisation with Basamid (dazomet) may have to be considered if available fields have become too weedy.

If residual herbicides are to be used it is often convenient to arrange plantings in batches according to herbicide susceptibility (Table 13).

Planting stock should be carefully checked to ensure the roots are not carrying perennial weed rhizomes or root fragments.

Herbicide options

The are no residual herbicide products with specific label recommendations for use on herbaceous stock.

Lenacil (Venzar Flowable) has been traditionally used on herbaceous stock and there is historical data on crop tolerance (Table 13). Lenacil tends to be less damaging in field situations than in the container crop, however, there is always the possibility of damage to any variety on light soils where heavy rainfall follows application.

Butisan S and Flexidor 125 have both been used on field-grown herbaceous crops but there is little published data on crop tolerance and no HDC trials have been undertaken on this crop, although there is considerable commercial experience with the use of Flexidor 125 on herbaceous crops (summarised in Table 13). Dual Gold has been used in the US on field-grown herbaceous crops and there is some crop safety information available from the US label (for Pennant Magnum) (Table 13). There are no label recommendations for the use of Butisan S, Dual Gold or Flexidor 125 on field-grown herbaceous nursery stock (although Butisan S and Flexidor 125 have approval for ornamental plant production and Dual Gold an EAMU) so any such use, whilst permitted, is entirely at the grower's own risk.

Non-chemical options

Cultivations may be used in combination with herbicide treatments. Typically, a residual herbicide is applied after planting. When this has lost residual activity cultivations may be used over the summer period when the soil is relatively dry, followed by another herbicide application in the autumn when the soil may be too wet to allow further cultivation.

It is possible to rely entirely on cultivations or mulches for weed control, and this may be the only option for certain herbicide sensitive species. To be successful, light soils are preferable and cultivations should be carried out regularly to ensure the weed seedlings do not get too large.

Control of perennial weeds in the crop

Most perennial weeds cannot be controlled by selective herbicides in the crop. However, where grasses are a problem, selective herbicides such as Aramo can be considered. Aramo does not possess a label recommendation for use in herbaceous crops although there is some information on crop tolerance (Table 13). Aramo currently has an EAMU for use in ornamentals, so can be used at growers' own risk.

Table 13. Tolerance of field-grown herbaceous crops to herbicides

Herbicide product / Crop	Devrinol	Dual Gold	Flexidor 125	Venzar Flowable
Approval status	**A**	**EAMU**	**A**	**LTAEU**
Achillea				
Aconitum				
Agapanthus				
Ageratum				
Alchemilla				
Anaphalis				
Anemone				
Anthemis				
Aquilegia				
Arenaria				
Artimesia				
Aruncus				
Aster				
Astilbe				
Astrantia				
Bergenia				
Campanula				
Carex				
Centranthus				
Chrysanthemum				
Coreopsis				
Cortaderia				
Crocosmia				
Dahlia				
Delphinium				
Dianthus				
Diascia				
Dicentra				
Dierama				
Digitalis				
Doronicum				
Endymion				
Epimedium				
Erigeron				
Eryngium				
Euphorbia				
Gaillardia				
Gazania				
Geranium				
Geum				
Gladaolus				

Table 13. Tolerance of field-grown herbaceous crops to herbicides

Herbicide product / Crop	Devrinol	Dual Gold	Flexidor 125	Venzar Flowable
Approval status	**A**	**EAMU**	**A**	**LTAEU**
Helenium				
Helleborus				
Hemerocallis				
Heuchera				
Hosta				
Iberis				
Iris				
Kniphofia				
Lavandula				
Ligularia				
Lilium				
Liriope				
Lithospermum				
Lobelia				
Lupinus				
Lychnis				
Lythrum				
Mesembryanthemum				
Muscari				
Narcissus				
Nepeta				
Nerium				
Oenothera				
Ophiopogon				
Origanum				
Ornithogalum				
Pachysandra				
Paeony				
Papaver				
Penstemon				
Phlox				
Phormium				
Physocarpus				
Physostegia				
Polygonum				
Potentilla				
Primula				
Pulmonaria				
Pulsatilla				
Rudbeckia				
Salvia				

Table 13. Tolerance of field-grown herbaceous crops to herbicides

Herbicide product / Crop	Devrinol	Dual Gold	Flexidor 125	Venzar Flowable
Approval status	**A**	**EAMU**	**A**	**LTAEU**
Scabiosa				
Sedum				
Sempervivum				
Sidalcea				
Silene				
Solidago				
Stachys				
Statice				
Tellima				
Thalictrum				
Tradescantia				
Trollius				
Veronica				
Vinca				
Viola				

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Label approval.

EAMU Off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials on plants prior to full scale treatment.

Tree and shrub seed beds

Soil sterilisation

Most growers usually carry out soil sterilisation in the autumn prior to sowing in the spring. As well as controlling soil-borne fungal diseases and nematodes, the chemicals used in the process also control any weed seeds present in the soil. A small number of products are available for use as soil sterilants, including Basamid (dazomet) and Metam-sodium (metham sodium).

Successful soil sterilisation depends upon a number of factors, including soil type (high levels of soil organic matter can reduce the efficacy of the chemicals), correct soil preparation, adequate soil temperatures and sufficient soil moisture.

The HDC project HNS 31 examined the use of a low rate Basamid application (100kg/ha) raked into the top 5 cm of the seed bed surface. The treatment performed well, achieving weed control levels similar to those achieved by the recommended rate treatment (380kg/ha) for at least 2-3 months following seed sowing, saving almost 75% on chemical costs. However this lower rate of Basamid will not give adequate control of soil-borne fungal diseases and nematodes.

Stale seed bed technique

This technique is often used to attain weed-free seed beds prior to crop germination. The technique involves the use of contact herbicides both prior to and after seed sowing in order to eradicate any weed seedlings present.

The final application of the herbicide requires precise timing, and should be made so that it catches the latest flush of weeds possible, at least 3-4 days before the emergence of the crop.

A number of products such as Finale, Reglone and Shark possess a label recommendation for use in this way.

Residual pre- and post-emergence herbicide options

There are no residual herbicides that currently have a label recommendation for use on tree and shrub seed beds.

In HDC project HNS 31a, a range of residual herbicides was applied before and after crop emergence over a number of different tree and shrub species. The results are summarised in Table 14. Unfortunately, the herbicides that gave the highest levels of weed control – Butisan S, Flexidor 125, lenacil and Ronstar Liquid – were also the ones that gave rise to the most damage to the tree and shrub seedlings. There were, however, some species where there was reasonable crop tolerance (Table 14).

One approach when using the more effective residual herbicides, is to apply them at low rates with top-up treatments as required. This system has been adopted by some growers with programmes based on low rates of Devrinol or Flexidor 125.

A further series of residual herbicide trials were carried out from 2007-2010 (HNS 155) and at the same time earlier herbicide research was published by Forestry Research (Willoughby et al 2003, 2007) making further information available which is also summarised in Table 14). These later trials confirmed that formulations of pendimethalin (such as Stomp Aqua) were probably the safest of the residual herbicide options with the widest range of species showing tolerance. However for many of the small seeded species the rate of use is relatively low (1 litre/ha). Forestry research suggested the use of a Stomp (Aqua) + Devrinol tank mix for selected tolerant species gave good levels of broad-leaved weed control. Devrinol is limited to application up to the end of April however. The results from HNS 155 also suggested that Centium 360 CS, Dual Gold or Goltix WG could be used at low rates to improve the weed control spectrum of Stomp Aqua. Centium 360 CS can however give temporary leaf bleaching and stunting if

heavy rain falls after application. Results also suggested a possible role for Springbok, but subsequent commercial experience has been that unacceptable stunting can sometimes occur.

In HNS 155 a more limited series of trials tested post-emergence herbicides such as Betanal Flow and Goltix WG for crop safety and efficacy. Treatments were applied at the four true leaf stage of the crop. Results are summarised in Table 14.

Table 14. Effects of residual herbicides on germination and seedling growth

Crop and herbicide effect / Herbicide product		Betanal Flow	Butisan S	Centium 360 CS	Devrinol	Dual Gold	Flexidor 125	Goltix WG	Intruder	Ronstar Liquid	Stomp Aqua	Venzar Flowable
Approval status		EAMU	A	LTAEU	A	EAMU	A	LTAEU	A	A	EAMU	LTAEU
Pre or post (P) crop emergence		P	Pre/P	Pre	Pre	Pre	Pre/P	Pre/P	P	Pre	Pre	Pre/P
Acer Campestre	Germination											
	Vigour/phytotoxicity											
Acer platanoides	Germination											
	Vigour/phytotoxicity											
Acer pseudoplatanus	Germination											
	Vigour/phytotoxicity											
Acer rubrum	Germination											
	Vigour/phytotoxicity											
Alnus glutinosa	Germination											
	Vigour/phytotoxicity											
Betula pendula	Germination											
	Vigour/phytotoxicity											
Carpinus betulus	Germination											
	Vigour/phytotoxicity											
Cornus alba	Germination											
	Vigour/phytotoxicity											
Cornus sanguinea	Germination											
	Vigour/phytotoxicity											
Corylus avellana	Germination											
	Vigour/phytotoxicity											
Cotoneaster franchetti	Germination											
	Vigour/phytotoxicity											
Crategus monogyna	Germination											
	Vigour/phytotoxicity											
Fagus sylvatica	Germination											
	Vigour/phytotoxicity											

Table 14. Effects of residual herbicides on germination and seedling growth

Crop and herbicide effect / Herbicide product		Betanal Flow	Butisan S	Centium 360 CS	Devrinol	Dual Gold	Flexidor 125	Goltix WG	Intruder	Ronstar Liquid	Stomp Aqua	Venzar Flowable
Approval status		EAMU	A	LTAEU	A	EAMU	A	LTAEU	A	A	EAMU	LTAEU
Pre or post (P) crop emergence		P	Pre/P	Pre	Pre	Pre	Pre/P	Pre/P	P	Pre	Pre	Pre/P
Fraxinus excelsior	Germination											
	Vigour/phytotoxicity											
Gleditsia triacanthos	Germination											
	Vigour/phytotoxicity											
Prunus avium	Germination											
	Vigour/phytotoxicity											
Prunus padus	Germination											
	Vigour/phytotoxicity											
Quercus robur	Germination											
	Vigour/phytotoxicity											
Rosa rubiginosa	Germination											
	Vigour/phytotoxicity											
Sorbus aucuparia	Germination											
	Vigour/phytotoxicity											
Sorbus intermedia	Germination											
	Vigour/phytotoxicity											

Tolerant	Crop damage does not normally occur.
Moderately susceptible	Some crop damage may occur but plants normally grow away.
Susceptible	Unacceptable crop damage normally occurs – do not treat.

A Label approval.

EAMU Off-label approval under Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (grower's own risk use).

LTAEU Off-label approval under the Long Term Arrangements for Extension of Use (grower's own risk).

Only a limited number of species and cultivars have been tested within each genus, it is therefore essential to carry out small scale trials on plants prior to full scale treatment.

Information sources

HDC projects HNS 31, HNS 155 and Willoughby et al 2003 and 2007.

These results refer to the following rates of use:

Product	Product rate	Active ingredient and concentration
Betanal Flowable	2.5 litres/ha	160 g/l phenmedipham
Butisan S	1.5 litres/ha	500 g/l metazachlor
Centrum 360 CS	0.125-0.250 litres/ha	360 g/l clomazone
Devrinol	2.2-5.0 litres/ha	450 g/l napropamide
Dual Gold	0.8 litres/ha	960 g/l s-metolachlor
Flexidor 125	0.8 litres/ha	125 g/l isoxaben
Goltix WG	1.5-3.0kg/ha	70% w/w metamitron
Intruder	2.0 litres/ha	400 g/l chlorpropham
Ronstar Liquid	4.0 litres/ha	250 g/l oxadiazon
Stomp 400 SC equivalent to Stomp Aqua	1.0-3.0 litres/ha 0.88-2.64 litres/ha	400 g/l pendimethalin 455 g/l pendimethalin
Venzar WP (Lenacil 80W) equivalent to Venzar Flowable	1.5kg/ha 2.7 litres/ha	80% w/w lenacil 440 g/l lenacil

Appendices

Herbicide damage

Introduction

It is important to realise that herbicides can damage crops, as well as protecting them from unwanted weed growth. Damage can occur via a number of different routes, understanding these will help avoid problems. It should also be borne in mind that the symptoms of herbicide damage can resemble those of other disorders, such as nutrient deficiencies. This section discusses the common causes of herbicide damage and a number of the symptoms, highlighting differences with symptoms of other disorders.

Causes of herbicide damage

Overdosing

A particular crop species may be tolerant of a herbicide at the recommended rate of application, showing no damage or only minor, adverse effects. However, if the recommended rate is exceeded, the crop's tolerance may be overcome and damage results. This may be because the crop cannot metabolise the amount applied sufficiently quickly. In the case of residual residual herbicides, selectivity may depend on the crop's roots being protected from the herbicide by the depth of growing medium or soil above the root zone. At high rates of application, significant amounts of herbicide may move into the crop's root zone. A poorly consolidated growing medium or soil surface may exacerbate this.

Overdosing can occur through mixing the wrong rate, but is more commonly due to sprayer or applicator overlaps. Faulty spray equipment such as defective nozzles may also lead to uneven application, as can inefficient mixing of water and herbicide in the spray tank. A fluctuating speed of travel during application will also produce under and over application.

Leaching

Downward movement of residual herbicides through the growing medium or soil can occur with drainage of water. This can take place in container growing media, though is more commonly associated with mineral soils of lighter (sandier) texture. Recommended application rates of some herbicides reflect the soil texture and it is important to assess this carefully. Over-application will increase the risk of damage from leaching.

Contamination

Some crop species are extremely sensitive to certain herbicides. Failure to clean out the sprayer thoroughly, including the boom or lance, before applying a different herbicide is a very common cause of herbicide damage.

The use of contaminated water for mixing, or the accidental contamination of spray concentrate with unused material poured back into the wrong container, have also caused occasional problems.

Spray drift

Spray droplets can drift for several hundred metres, under windy conditions. Droplets of contact herbicides, such as diquat, can cause unacceptable spotting even over this distance. If the herbicide is mobile in the plant, such as glyphosate, the damage may be far more severe.

Vapour damage

Some herbicides may be volatile and work partly or largely by vapour action. This may restrict their use to outdoors only. Application under protection or close to protected crops may lead to unacceptably high levels of vapour accumulating around the crop, even with crops which are normally tolerant of the herbicide in an outdoor situation.

Growing media or soil residues

A number of herbicides can be persistent in soils or plant debris. Carry over of damaging herbicide residues in mineral soils can occur if the herbicide was over-applied, or the time interval to the following crop was too short. Some herbicides, such as clopyralid and glyphosate can remain active in undecomposed plant remains. If such material is incorporated into the soil before planting, or is used as part of the growing medium, root uptake and crop damage can occur.

Environmental conditions

Crops commonly experience some level of stress when treated with herbicides, even if they show no symptoms of damage. If the crop is already under stress from other causes, or experiences other stresses at the time of herbicide application, damage can occur. For this reason, it is important to minimise all stresses on the crop when using herbicides. Drought, excessive wetness, high or low temperatures and nutrient deficiencies may all trigger an adverse response to a herbicide. Rapid movement of systemic herbicides (and other pesticides) under conditions of high transpiration and rapid growth, can also lead to excessive accumulation at leaf tips and growing points, with consequent damage. The use of certain fungicides such as bupirimate has also been known to predispose crops to herbicide damage where the herbicide has been applied shortly after the fungicide.

Guidance

All these situations should have been considered in the instructions for use. If the herbicide label is read and followed carefully, crop damage is unlikely to occur.

Examples of herbicide damage

1. Clopyralid

Symptoms of clopyralid damage often include leaf thickening. Sometimes the leaf shape is narrowed (strap-like), particularly at the petiole end and the veins and mid-rib stand out as being wider. Damage can occur both from inadvertent spray drift and also from root uptake where heavy spot treatment has resulted in the chemical leaching into the root zone. Plants are most at risk from damage when rapidly growing in the spring or early summer.

Typical damage to *Corylus* showing leaf distortion, the affected leaves are thickened and cupped where the leaf margin has failed to expand

2. Diquat

Diquat is a non-selective contact herbicide often used as a directed spray to kill weeds adjacent to the crop row. Damage can occur as a result of drift onto the crop foliage. Slight drift will result in irregular yellow blotches across the leaf, often with a well defined border. *Hosta* will also develop a purple border to the damaged areas. In more extreme damage the centre of the blotches will become brown and necrotic and the blotches can coalesce. The distribution of the damage will often indicate the direction from which the spray drift occurred.

Damage symptoms on *Hosta*

3. Glyphosate

The youngest leaves are normally most affected. Typically the main leaf veins will remain green but will appear very narrow. Leaf shape can be affected with some narrowing and strap-like leaves with cupped margins appearing at the shoot tips. Where damage occurred in the previous growing season there may be an extreme proliferation of weak shoots ('witches broom') the following spring. The leaf yellowing from glyphosate damage can be confused with iron deficiency, but with the latter there is no leaf distortion and the interveinal chlorosis may be more uniform across the leaf.

Typical damage to *Quercus* showing bright yellow coloration of the affected leaves

4. Isoxaben

Where the leaf margin is affected the leaf continues to expand giving a cupped like effect. Yellow blotching is quite common with isoxaben damage too. There may also be stem base and root thickening. *Buddleia* are affected and will exhibit black gumming from the stems, although this is a stress symptom, not exclusive to herbicide damage.

Typical damage symptoms on large leaved *Cornus* showing yellowing, particularly at the edge of the leaf, leaf puckering and necrosis at the edge of the leaf

5. Lenacil

Damage normally shows up on the oldest leaves first as veinal yellowing. Lenacil damage can occur on a wide range of crops, typically when heavy rain or irrigation follows application, leaching the chemical into the rooting zone. Newly planted and rapidly growing crops are most at risk from damage.

Typical damage on *Deutzia* showing wide veinal yellowing

6. Metam-sodium

Used as a soil sterilant for forest seed beds. When sowing too early after treatment, damage to the seedlings can occur, including stunting and twisting of foliage.

Browning of the foliage of *Abies koreana*

7. Metazachlor

Metazachlor causes a general leaf scorching to a wide range of subjects, when applied to soft or active growth. Typically the leaf margin is scorched where spray deposits accumulate. The youngest leaves also have some scorching to the leaf margin. Metazachlor damage symptoms on *Buddleia* are also similar to isoxaben damage, black gumming can often be seen oozing from the stems and leaves.

Typical damage symptoms on *Buddleia,* showing irregular yellowing tending to be concentrated around the margin of the leaf

Nutrient deficiencies that could be mistaken for herbicide damage

1. Iron deficiency

A very bright bleached yellow colouration, more extreme on the youngest leaves. Sometimes there can be a sun scorch to the most bleached leaves. The veins, including the finer veins, tend to remain green, particularly in the less deficient older leaves. This could be confused with glyphosate damage, but with iron deficiency there is no leaf distortion and the veins tend to have a wider green band. Iron deficiency is common on soils or growing media with a high pH or in waterlogged conditions.

Iron deficiency symptoms on *Calceolaria*

2. Magnesium deficiency

Symptoms tend to be a regular interveinal yellowing between the major veins. On crops other than chrysanthemum, however, the chlorosis tends to be concentrated towards the margin of the leaf and there can be irregular necrotic blotches as well.

Magnesium deficiency symptoms on chrysanthemum

3. Manganese deficiency

These symptoms can be found on crops growing on high pH soils, particularly where there is some waterlogging. On many crops it tends to be the older leaves which are affected first with a faint diffuse interveinal yellowing. The vein network often remains a more uniform green than with iron deficiency. The very regular pattern contrasts with the more irregular interveinal yellowing associated with some herbicide damage symptoms.

Manganese deficiency symptoms on pea

4. Potassium deficiency

Leaves tend to be small and relatively long-stalked; edges dry and curl up beginning in the oldest leaves of a shoot and spreading gradually up the shoot. The old partially dried up leaves tend to remain on the shoot. Typically, symptoms start with chlorosis on the leaf margins, which later turns to necrosis. Older leaves are affected first. Symptoms tend to be more regular than those of herbicide damage.

Potassium deficiency symptoms on hop

Identifying herbicide damage

When attempting to identify whether herbicide damage has occurred it is important to rule out any other factors, the symptoms of which could be confused with herbicide damage.

Firstly identify the nature and distribution of the symptoms. Most visible herbicide damage symptoms can be categorised into the following types:

- Scorch particularly to the edge of the leaf.
- Interveinal yellowing with or without marginal scorch.
- Veinal yellowing.
- Marginal yellowing.
- Blotchy yellowing with or without scorch.
- Yellowing to the shoot tips.
- Leaf or shoot curling/twisting (epinasty).
- Leaf distortion.
- Other coloration – white and pink.
- Root or stem-base swelling.

When checking scorch symptoms, look for the distribution pattern on the leaf. If it is very regular and associated with older leaves it may be a nutrient deficiency. If it is mainly on the edge of a batch it could be wind damage or drying out. Does the pattern suggest a spray application, which could be uneven? Consider if other pesticide applications have been made, some fungicides and insecticides can cause scorch or discolouration if applied under hot conditions.

Yellowing can be caused by both nutrient deficiencies and herbicide damage. Veinal yellowing is unlikely to be caused by nutrient deficiencies. Interveinal yellowing and blotching may be caused by either nutrient or herbicide damage. Diquat damage often crosses leaf veins.

If the damage cannot be matched to the images, then a soil or leaf analysis may need to be conducted, to check for nutrient deficiencies or imbalances. Soil analysis is more reliable for diagnosing phosphorus, potassium and magnesium deficiencies. Note that leaf analysis cannot be used to identify iron deficiency reliably – this is best done by visual diagnosis and checking soil pH.

Leaf distortion is frequently associated with 'hormone' type herbicides. There are a few other causes with which it can be confused, for example, *Colletotrichum* infection on lupins which causes severe stem curling. A number of bacterial infections can also cause a 'witches broom' effect of shoot proliferation. Some hormone herbicides can cause leaf and stem curling along with vein and leaf margin distortion.

Other leaf colouration such as white or pink would be typical of amitrole herbicide damage. There are no other pesticides in normal use that would cause this colouration, but check first that the colours seen are not a normal characterisitic.

Legal, health and safety issues

Pesticide legislation

The Food and Environment Protection Act 1985 (FEPA) and Control of Pesticides Regulations 1986 (COPR)

FEPA introduced statutory powers to control pesticides with the aim of protecting human beings, creatures and plants, safeguarding the environment, ensuring safe, effective and humane methods of controlling pests and making pesticide information available to the public. This was supplemented by Control of Pesticides Regulations 1986 (COPR) which has now been replaced by EC Regulation 1107/2009 (see below). Details are given on the HSE-CRD website (http://www.pesticides.gov.uk).

The controls currently in force of particular relevance to nursery stock herbicide use include the following:

- Only approved products may be sold, supplied, stored, advertised or used.
- A recognised Storeman's Certificate of Competence is required by anyone who stores for sale or supplies pesticides approved for agricultural use.
- A recognised Certificate of Competence is required by anyone who gives advice when selling or supplying pesticides approved for agricultural use.
- Users of pesticides must comply with the Conditions of Approval relating to use.
- A recognised Certificate of Competence is required by all contractors and persons born after 31 December 1964 applying pesticides approved for agricultural use (unless working under the direct supervision of a certificate holder).
- Only those adjuvants authorised by CRD may be used.
- Regarding tank mixes, no person shall combine or mix for use two or more pesticides which are anti-cholinesterase compounds, unless the approved label of at least one of the pesticide products states that the mixture may be made; and no person shall combine or mix for use two or more pesticides if all the conditions of the approval relating to this use cannot be complied with.

EC Directive 91/414/EEC

European Council Directive 91/414/EEC, also known as the 'Authorisation Directive', harmonised national arrangements for the authorisation of plant protection products within the European Union. It became effective in 1993. Under the provisions of the Directive, individual Member States are responsible for authorisation within their own territory of products containing active substances that appear in a list agreed at Community level (Annex 1 list). In the UK this has been achieved by a series of Plant Protection Products Regulations (PPPR), under which all agricultural and horticultural pesticides are regulated. The Directive also provides for a system of mutual recognition of products registered in other Member States, subject to a number of constraints.

EC Regulation 1107/2009

Regulation 1107/2009 came into force in the EU on 14 December 2009 and was applied to new approval applications from 14 June 2011. Since that date all pesticides that hold a current approval under previous EC Directive 91/414/EEC are taken as approved under 1107/2009 and the new criteria for approval will only be applied when the active substance comes up for review. The new regulation largely

mirrors 91/414/EEC but requires additional approval criteria to be met to remove the more hazardous chemicals. The full criteria for approval decisions have yet to be defined in some cases.

The Control of Substances Hazardous to Health Regulations 2002 (COSHH)

The COSHH Regulations, which came into force on 1 October 1989, were made under the Health and Safety at Work Act 1974 and are also important as a means of regulating the use of pesticides. The regulations cover virtually all substances hazardous to health, including those pesticides classed as very toxic, toxic, harmful, irritant or corrosive, other chemicals used in farming or industry and substances with occupational exposure limits. They also cover harmful micro-organisms, dusts and any other material, mixture or compounds used at work, which can harm people's health.

The basic principle underlying the COSHH Regulations is that the risks associated with the use of any substance hazardous to health must be assessed before it is used and the appropriate measures taken to control the risk. The emphasis is changed from that pertaining under the Poisonous Substances in Agriculture Regulations 1984 (now repealed), whereby the principal method of ensuring safety was the use of protective clothing, to the prevention or control of exposure to hazardous substances by a combination of measures.

In order of preference the control measures should be:

1. Substitution with a less hazardous chemical or product.
2. Technical or engineering controls (e.g. the use of closed handling systems etc).
3. Operational controls (e.g. operators located in cabs fitted with air-filtration systems etc).
4. Use of personal protective equipment (PPE), which includes protective clothing.

Consideration must be given as to whether it is necessary to use a pesticide at all in a given situation and, if so, the product posing the least risk to humans, animals and the environment must be selected. Where other measures do not provide adequate control of exposure and the use of PPE is necessary, the item stipulated on the product label must be used as a minimum. It is essential that equipment is properly maintained and the correct procedures adopted. Where necessary, the exposure of workers must be monitored, health checks carried out and employees must be instructed and trained in precautionary techniques. Adequate records of all operations involving pesticide application must be made and retained for at least 3 years.

Certificates of Competence – the role of BASIS and NPTC

COPR, COSHH and other legislation places certain obligations on those who handle and use pesticides. Minimum standards are laid down for the transport, storage and use of pesticides and the law requires those who act as storekeepers, sellers and advisors to hold recognised Certificates of Competence.

BASIS is an independent registration scheme for the pesticide industry, recognised under COPR. It is responsible for organising training courses and examinations to enable such staff to obtain a Certificate of Competence.

In addition, BASIS undertakes annual assessments of pesticide supply stores, enabling distributors, contractors and seedsmen to meet their obligations under the Code of Practice for Suppliers of Pesticides. Further information can be obtained from BASIS.

Certain spray operators also require Certificates of Competence. These are issued by the National Proficiency Tests Council (NPTC) and are application method specific. The foundation module is Pesticide Application (PA) 1 and is undertaken prior to the required application module. A range of application modules are then available covering a number of sprayer types, PA6A, for example, covers handheld applicators including knapsacks and powered trolley sprayers.

The Voluntary Initiative – training for spray operators

The Voluntary Initiative (www.voluntaryinitiative.org.uk) is a programme of measures, agreed by Government, to minimise the environmental impacts of pesticides.

The National Register of Spray Operators (NRoSO) is a central register of spray operators using Continuing Professional Development (CPD) as a means of ensuring ongoing training. The scheme is open to anybody who holds an appropriate NPTC PA certificate of competence, or was born before 31 December 1964 and is applying pesticides under 'Grandfather Rights'.

Members have to attend training events and collect sufficient CPD points to qualify for membership renewal. Although membership of NRoSO is not a legal requirement, it is a requirement for many crop assurance schemes.

Members must:

- Ensure that any equipment is being used in accordance with current legislation.
- Have due regard to any environmental impact.
- Give priority to the health and safety of bystanders and those that purchase/use/consume crops being treated.
- Use equipment that affords relevant protection to operators under current health and safety legislation.

The National Sprayer Testing Scheme (NSTS) was set up to provide an independently validated, low cost annual, testing scheme to meet various requirements, including assurance schemes, processor/retailer production protocols as well as satisfying the desire of many operators to verify the accuracy and overall fitness of their pesticide application requirement. Testing is undertaken by a 'test centre' and conducted by a trained examiner who holds a valid NPTC level 3 Certificate of Competence. A list of all the 'test centres' in the UK is available from NSTS.

Pesticide approvals

Only officially approved pesticides may be marketed and used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the specific statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Statutory conditions of use

Statutory conditions have been laid down for the use of individual products and may include:

- Field of use.
- Crop or situations for which treatment is permitted.
- Maximum individual dose.
- Maximum number of treatments or the maximum total dose.
- Maximum area or quantity which may be treated.
- Latest time of application or harvest interval.
- Operator protection or training requirements.
- Environmental protection requirements.
- Any other specific restrictions relating to particular pesticides.

All products must now display these statutory conditions of use in a 'statutory box' on the product label.

Types of approval

There are two categories of approval that may be granted:

- Authorisation for use
- Limited approval for research and development (granted for the purposes of testing and developing new products, formulations or uses).

The official list of approved products, including all the above categories except those for experimental purposes, is on the HSE-CRD website (http://www.pesticides.gov.uk).

Withdrawal of approval

Product approvals may be reviewed, amended, suspended or revoked at any time. Revocation may occur for various reasons, such as commercial withdrawal or failure by the approval holder to meet data requirements. Where there are no safety concerns, a phased approval revocation is implemented, specifying a 'wind-down' period (usually 12 months) to allow the use up of stocks by persons other than the approval holder. This is known as the phased revocation procedure. Where safety considerations make it necessary, however, immediate revocation may occur.

Approval of commodity substances

Some chemicals have minor uses as pesticides but are predominantly used for non-pesticidal purposes. For a commodity substance to be used as a pesticide, it requires approval under the Control of Pesticides Regulations. Approval is granted to such commodity substances for use only. Approval is not given for sale, storage, supply or advertisement. Commodity substances are shown on the HSE-CRD website (http://www.pesticides.gov.uk).

Off-label extension of use

Products may legally be used in a manner not covered by the printed label in several ways:

- In accordance with the 'Off-Label Arrangements' (see next section).
- In accordance with a Specific Off-Label Approval (SOLA), now termed Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU). EAMUs are uses for which approval has been sought by individuals or organisations, for example the HDC. The Notices of Approval are published by Defra and are available from the HSE-CRD website (http://www.pesticides.gov.uk), ADAS or NFU offices and the HDC. Users of EAMUs must first obtain a copy of the relevant Notice of Approval and comply strictly with the conditions laid down there in.
- In tank mixtures with other approved pesticides in accordance with Schedule 3 made under FEPA. Full details of Schedule 3 are given in Annex A of the Guide to Approved Pesticides on the HSE-CRD website. There are two essential requirements for tank mixes. Firstly, all the conditions of approval of all the components of a mixture must be complied with. Secondly, no person may mix or combine pesticides which are anticholinesterase compounds unless allowed by the label of at least one of the pesticides in the mixture.
- In conjunction with authorised adjuvants.
- In reduced spray volume under certain conditions.
- The application of certain herbicides on specified set-aside areas subject to restrictions which differ between Scotland and the rest of the UK.
- By mutual recognition of or use fully approved in another Member State of the European Union and authorised by CRD.

Although approved, off-label uses are not endorsed by manufacturers and such treatments are made entirely at the risk of the user.

The Off-Label Arrangements

Since 1 January 1990, arrangements have been in place allowing many approved products to be used for additional specific minor uses. These were revised in 1999 and again in 2002 to become The Long Term Arrangements for Extension of Use 2002. Note that these arrangements apply to products containing active substances approved under COPR prior to the implementation of Directive 91/414 EEC on 15 July 1993. Active substances new to the UK after 15 July 1993 are specifically excluded where they are not present in a product also containing an active substance approved prior to this date.

A list of products that can still be used for ornamental production under the Long Term Arrangements for Extension of Use can be found on the HDC website (www.hdc.org.uk) by following the link to the Liaison LTAEU database, after logging in. The arrangements are set out in full on the HSE-CRD website.

Specific restrictions for extension of use

Certain restrictions are necessary to ensure that the extension of use does not increase the risk to the operator, the consumer or the environment:

- Extensions of use may be made from label recommendations, Specific Off-Label Approvals (SOLAs) and Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product (EAMU), but only for the use of products approved for use as agricultural or horticultural pesticides.
- Safety precautions and statutory conditions relating to use as specified on the label and off-label approval must be observed. The application method must be as stated on the product label or off-label approval and in accordance with relevant Codes of Practice and COSHH requirements. Where application of a pesticide under these arrangements is made by hand-held equipment, users must ensure that hand-held use is appropriate for the current label or SOLA/EAMU notice conditions.
- Pesticides must only be used in the same situation as that on the product label or SOLA/EAMU notice i.e. outdoor or protected. Approval for use on tomatoes, cucumbers, lettuces, chrysanthemums and mushrooms include protected crops unless otherwise stated. Use on other protected crops must be specifically permitted on the label or off-label approval. Similarly, pesticides approved for use only in protected situations must not be used outdoors. If a label or SOLA/EAMU notice does not specify a situation, then extrapolation only to an outdoor use is permitted.
- Off-label use in or near water, or by aerial application, is not permitted under the arrangements.
- Rodenticides are not included, nor is use on land not intended for cropping.
- Pesticides classed as harmful, dangerous, extremely dangerous or high risk to bees must not be used off-label on any flowering crop.
- If the label or SOLA /EAMU notice specifies an aquatic buffer zone, users must conduct a Local Environment Risk Assessment for Pesticides (LERAP) for the extension of use.
- The user of a pesticide under these arrangements must take all reasonable precautions to safeguard wildlife and the environment.

Extension of use applications

Non-edible crops and plants (including nursery stock)

Subject to the specific restrictions set out previously, pesticides approved for use on any growing crop may be used on commercial holdings and forest nurseries on ornamental crops including hardy nursery stock, plants, bulbs, flowers and seed crops where neither the seed nor any part of the plant is to be consumed by humans or animals and forest nursery crops prior to final planting out.

In addition, pesticides approved for use on any growing edible crop (except seed treatments) may be used on non-ornamental crops grown for seed subject to the same consumption restrictions as above (but not including seed crops of potatoes, cereals, oilseeds, peas and beans).

Pesticides (except seed treatments) approved for use on oilseed rape may be used on hemp grown for fibre.

Farm forestry and rotational cropping

Subject to the specific restrictions set out previously, herbicides approved for use on cereals may be used in the first five years of establishment in farm forestry on land previously under arable cultivation or improved grassland.

In addition, herbicides approved for use on cereals, oilseed rape, sugar beet, potatoes, peas and beans may be used in the first year of re-growth after cutting in coppices established on land previously under arable cultivation or improved grassland.

Nursery fruit crops and hops

Subject to the specific restrictions set out previously, pesticides approved for use on any crop for human or animal consumption may be used on hops in specified circumstances and in commercial holdings on nursery fruit trees, nursery vines prior to final planting out, bushes, canes and non fruiting strawberries, provided any fruit harvested within one year is destroyed. Applications must not be made if fruit is present.

Groundwater Regulations

The Groundwater Regulations came into force on 1 April 1999 to enable implementation of the European Groundwater Directive.

The Regulations apply to the disposal of certain substances onto land. The full list of substances is shown in guidance notes available from the Environment Agency and the Scottish Environment Protection Agency (SEPA). Substances are divided into two lists, with List 1 representing substances which pose the greatest threat to groundwater. These substances must not be permitted to enter groundwater. Of the substances in List 1, the one of particular relevance to horticulture is 'pesticides', which have all been grouped together. This means that wherever pesticides are disposed of onto land, then Environment Agency authorisation is required (England and Wales). Growers in Scotland should apply to SEPA.

Disposal of substances on List 2 also requires authorisation for disposal onto or into land, as again such substances must be prevented from polluting groundwater. List 2 contains substances including phosphorus, ammonia and nitrite, which may be present in fertiliser as well as any biocides not covered in List 1.

Applying for authorisation

An application for authorisation is not required if:

- All pesticides used are applied to the crop and there is no waste remaining.
- Any washings, which will contain diluted pesticides, are put back on the crop (without exceeding the label rate).

An application for authorisation is required if any pesticides (including washings) are disposed of onto uncropped land. In the past, many growers relied on a small area of uncropped land to dispose of pesticide washings. This practice is now illegal without authorisation.

Growers that want to continue the disposal of pesticides and other listed substances, such as 'biocides', should contact the Environment Agency or SEPA. An initial charge is made at

the application stage, followed by an annual subsistence charge. These fees are to pay for monitoring and inspections as required by the regulations. Applicants should provide as much information as possible to help the Environment Agency or SEPA in their assessment of each application. The Agencies will try to help applicants find the most suitable disposal sites.

In many cases a change of practice can help growers avoid the need to apply for authorisation. Accurate calibration of pesticide applications and disposal of washings onto the treated area (without exceeding the maximum label rate) can eliminate the need for pesticide disposal altogether. The Environment Agency and SEPA support this advice but as soon as listed substances are disposed of to land then authorisation must be obtained. Contact the Environment Agency on 08708 506506 or SEPA on 01349 862021 (SEPA North Region, Dingwall), 0131 4497296 (SEPA East Region, Riccarton) and 01355 574200 (SEPA West Region, East Kilbride) for further advice.

Local Environmental Risk Assessment For Pesticides (LERAP)

From 1990 some pesticides could only be used near a watercourse or ditch if a buffer zone was adhered to. This buffer zone represented the distance of the spray application from a watercourse. The arrangements for the use of pesticides with buffer zone requirements near water, have been revised with effect from March 1999. These guidelines should be read in conjunction with the booklet, 'Local Environmental Risk Assessments for Pesticides: Horizontal Boom Sprayers PB5621 (available free from Defra Publications, telephone 08459 556000). The LERAP scheme provides growers with greater flexibility for pesticide application near watercourses with the option of reducing buffer zones in certain cases, following completion of a LERAP.

The method of measuring buffer zones has been changed. Zones are no longer measured from the edge of the water; the distance is now measured from the top of the bank of the watercourse and distances have been reduced by one metre to take account of this.

- For hand held sprayers the standard buffer zone is now one metre, rather than two metres.
- For ground crop sprayers the standard buffer zone is now five metres, instead of six metres.
- For seasonally dry ditches a standard buffer zone of one metre from the top of the ditch's bank applies in all cases.

(These arrangements do not apply to pesticide products applied in a vertical plane by orchard or hop sprayers, although statutory buffer zones on product labels apply.)

Pesticides with buffer zone requirements have been grouped into two categories:

- Category 'A' is composed of all products containing organophosphate or synthetic pyrethroid pesticides. (Products which are extremely dangerous to fish and aquatic life.)
- Category 'B' is composed of all other products for which a buffer zone is required.

It is now a legal obligation to carry out and record the results of a 'Local Environmental Risk Assessment for Pesticides' (LERAP), for Category 'B' pesticides with a buffer zone requirement, when applied by a ground crop sprayer. There is currently no requirement to carry out a LERAP when using a hand held sprayer or an orchard or hop sprayer.

Users must comply with the five metre buffer zone in all cases for Category 'A' pesticides and no LERAP is required. Reducing the size of the buffer zone is only an option for pesticides in Category 'B'. A LERAP may allow a five metre buffer zone to be reduced to one metre from the top of the bank for a Category 'B' pesticide, if the LERAP shows this to be acceptable.

How to undertake a LERAP

The process should follow the steps outlined below and should be undertaken by the user (normally the person actually doing the spraying), whenever a Category 'B' pesticide

is used or annually if the 'worst case scenario' has been assessed:

1. Decide whether it is necessary to use a pesticide. There may be other methods of control that will present a lesser danger to watercourses.

2. Identify whether the pesticide concerned is eligible for a reduced buffer zone under the rules of the scheme. This is done by checking the category listings. The majority of horticultural products will not currently require any formal buffer zone, although many are harmful to fish and aquatic life and sensible precautions should be taken routinely, especially near drains and hard surfaces. The number of products in Category 'A' is relatively low and where possible, if a watercourse is present, an alternative product either in Category 'B' or one not requiring any buffer zone may be just as appropriate. For these reasons it is important to know which category products come into. There are two main sources of this information. These are on the HSE-CRD website http://www.pesticides.gov.uk or via e-mail from CRD Information Section at pesticides@hse.gsi.gov.uk

3. Decide whether to retain the standard five metre buffer zone or to explore the potential for a reduced buffer zone. If the option to retain the five metre buffer zone is chosen move to Step 8.

4. Check whether the sprayer in use qualifies as a recognised LERAP 'low drift' sprayer and if so, what star rating it has obtained. This should be recorded as part of the LERAP but need only be recorded annually, unless changes are made through the year.

5. Decide whether it is appropriate to apply the product at a reduced dose. Reducing the dose will give greater flexibility in the LERAP.

6. Establish the size of the watercourse(s) adjacent to the area where the proposed application is to take place. This need only be recorded annually if the 'worst case scenario' is chosen. The narrower the watercourse, the greater the pollution risk. Dry ditches must be considered as streams less than three metres in width and permanent watercourses assessed at their lowest flow, when pollution poses the greatest risk.

7. Calculate the buffer zone applicable to the proposed spray operation. Table 15 can be used to calculate the buffer zone reduction once the above steps have been completed.

8. Make a record of the conclusions reached as a result of the LERAP. (If the standard five metre buffer zone is to be applied, that decision must be recorded).

   If a full LERAP is carried out the following should be recorded at each spray application (some items can be recorded annually to represent a 'worst case scenario'):

   - The date of the final assessment.
   - The type of sprayer used (including rating).
   - The product being applied.
   - The dose at which the product is to be applied.
   - The watercourse size.
   - The result of the LERAP (i.e. the size of the buffer zone applied).
   - The identity of the person carrying out the LERAP.

9. As a reminder, the following should be recorded at each spray application as part of standard record keeping for all pesticide use:

   - Date and time of the spray operation.
   - Name of the operator.
   - Site of application.
   - Crops to be treated.
   - Reason for treatment.

- Product in use.
- Dilution and application rate.
- Duration of application.
- Weather conditions.
- Other relevant information.

10. Carry out the spray operation.

Table 15. LERAP sprayer summary

Sprayer type and dose	Watercourses less than 3m	Watercourses 3-6m	Watercourses greater than 6m	Dry ditch
A Standard reference sprayer				
Full dose	5m	3m	2m	1m
3/4 dose	4m	2m	1m	1m
1/2 dose	2m	1m	1m	1m
1/4 dose	1m	1m	1m	1m
B LERAP - Low drift * sprayer				
Full dose	4m	2m	1m	1m
3/4 dose	2m	1m	1m	1m
1/2 dose	1m	1m	1m	1m
1/4 dose	1m	1m	1m	1m
C LERAP - Low drift sprayer**				
Full dose	2m	1m	1m	1m
3/4 dose	2m	1m	1m	1m
1/2 dose	1m	1m	1m	1m
1/4 dose	1m	1m	1m	1m
D LERAP - Low drift * sprayer**				
Full dose	1m	1m	1m	1m
3/4 dose	1m	1m	1m	1m
1/2 dose	1m	1m	1m	1m
1/4 dose	1m	1m	1m	1m

Storage of pesticides

If pesticides are being stored for use, as opposed to sale or supply, reference should be made to the Health and Safety Executive's (HSE) Agriculture Information Sheet No 16 'Guidance on storing pesticides for farmers and other professional users'. Those involved in the sale, supply and storage for sale of 'pesticides approved for agricultural use' should refer to the Code of Practice for Suppliers of Pesticides to Agriculture, Horticulture and Forestry (the 'Yellow Code').

In order to comply with legislation on pesticide storage, the following key pesticide store requirements must be considered.

Size

The store should be large enough to contain peak storage requirements of pesticide containers without double stacking. Empty rinsed containers should be stored in a dedicated secure compound as well as allowing space for staff to move.

Location

Ensure the store is correctly and legally sited by consulting with your local authority planning department and the Environment Agency

or, in Scotland, the Scottish Environment Protection Agency. Stores should be sited away from areas that present a fire risk and at least four metres away from hay, straw, diesel, oils, paints, fertilisers, paper, wood stacks, domestic dwellings, gas containers and other combustible materials and sources of ignition. Do not site stores near to drains, watercourses, wells and boreholes or areas liable to flooding. Cabinet stores should be correctly located away from domestic dwellings, retail areas, staff rooms, offices or areas where human or animal food is stored or prepared.

Construction

The store (including doors, but not the roof), should be able to resist fire for at least 30 minutes. It should be capable of retaining leakage/spillage to at least 110% of the total quantity of products likely to be stored (this should be increased to 185% if the store is within an environmentally sensitive area). Bunding is normally used to achieve this. Bunding should be soundly constructed and non permeable.

The store should be roofed, frost free and secure against unauthorised access. The store should be kept locked when not in use.

Existing structures can be converted and cabinets, bins and chests can also be used as stores as long as the above requirements are met.

Signs

The exterior of the store should be marked with a general danger warning sign as well as a 'No Smoking' or 'Smoking and Naked Flames Forbidden' sign.

Store organisation

The store should contain adequate shelving and powders should be stored above liquids. The store should be adequately lit but direct sunlight avoided. Any water pipes should be lagged and implements should be available to deal with leakages and spillages. Do not store non-approved stock or old containers for long periods. Ensure that a list of contact details are available including the local fire service and Environment Agency.

Mobile storage

Specific instructions apply to transporting pesticides. HSE Agriculture Information Sheet No 16 should be referred to for more details.

Special classes of pesticides

Specific guidance applies to the storage of certain pesticides, moisture activated gassing compounds and oxidising agents. Refer to the HSE leaflet for further guidance.

List of relevant HDC funded projects

Code	Title	Reports Available
HNS 175	Liverwort control using novel techniques	Annual 2012
HNS 167	Hardy ornamental nursery stock: Preventing outdoor container-grown nursery stock plants rooting through into capillary sand beds via the use of herbicide treatments to the surface of the bed	Final 2009
HNS 166	Hardy ornamentals: Herbicide screening for herbaceous perennials and grasses	Final 2011
HNS 155	Nursery stock: Herbicide screening for tree seed beds	Final 2010
HNS 147	Ornamentals: Control of pests, pathogens and weed seeds on re-used plant containers	Final 2007
HNS 139a	Container-grown HNS: Further crop safety screening of Dual Gold (s-metolachlor) and Sumimax (flumioxazine)	Final 2012
HNS 139	Control of problem weeds in hardy nursery stock production	Final 2009
HNS 132	Roses: Triazine-free herbicide programmes	Final 2008
HNS 126	Biology, epidemiology and control of liverwort infestation of nursery plant containers	Final 2006
HNS 111	Container HNS: Herbicides for shrubs and herbaceous perennials for use in the growing crop	Final 2003
HNS 93c	Protected container-grown nursery stock: Chemical and non-chemical screening for moss and liverwort control in liners	Final 2004
HNS 93a	Moss, liverwort and algae in HNS	Final 2003
HNS 93	Nursery stock propagation: Moss liverwort and algae control	Final 2001
HNS 82	Control of aquatic weeds in nurseries and water storage systems: A literature review	Final 1997
HNS 78	Field-grown trees: The effect of current herbicide programmes on bud-take and maiden tree growth	Final 2000
HNS 74	Chemical weed control in container-grown alpines	Final 1998
HNS 70a	Container HNS: Use of contact herbicides in the nursery situation	Final 2000
HNS 70	The use of contact herbicides on container-grown nursery stock over winter	Final 1997
HNS 66	Non-chemical weed control in nursery stock	Final 1998
HNS 35g	Chemical weed control in container-grown nursery stock under protection	Final 1998
HNS 35f	Assessment of efficacy and phytotoxicity of herbicides on outdoor container-grown nursery stock	Final 1996
HNS 35e	Chemical weed control in outdoor container-grown herbaceous perennial nursery stock	Final 1993

HNS 35d	Chemical weed control in sand beds for hardy ornamental nursery stock	Final 1993
HNS 35c	Comparison of sand bed chemical treatments	Final 1994
HNS 35b	Container HNS: Herbicide screening under protection	Final 1995
HNS 35a	Chemical weed control in outdoor container-grown hardy ornamental nursery stock	Final 1996
HNS 35	Investigation of the efficiency and phytotoxicity of herbicides for use in container HNS production outdoors	Final 1993
HNS 31a	Tree and shrub seed beds: Continued evaluation of weed control treatments	Final1997
HNS 31	Evaluation of weed control treatments in tree and shrub seed beds and first year outdoor transplants	Final 1993
HNS 28a	Chemical weed control in outdoor container-grown hardy ornamental nursery stock	Final 1996

All the grower summaries from the reports referred to can be found by following the search facility on HDC's website at www.hdc.org.uk.

References

Acts of Parliament

- The Health and Safety at Work Act (1974).
- The Wildlife and Countryside Act (1981).
- The Food and Environment Protection Act (1985), Part III Pesticides (ISBN 0-10-544885-0).
- The Environmental Protection Act (1990).
- The Water Resources Act (1991).
- The Clean Air Acts (1956, 1968 and 1993).

Regulations

- Pesticides (Maximum Residue Levels in Crops, Food and Feeding Stuffs) Regulations, 1994. (SI No. 1985), (ISBN 0-11-044985-1) and subsequent amendments.
- The Control of Pesticide Regulations (COPR), 1986 (SI No. 1510), (ISBN 0-11-242892-4) and The Control of Pesticides (Amendment) Regulations (COP[A]R), 1997 (SI No. 188).
- Control of Substances Hazardous to Health, 1994 (COSHH) (SI No. 3246).
- The Plant Protection Products Regulations 1995 (PPPR) (SI No. 887); the Plant Protection Products (Amendments) Regulations 1996 (PPP[A]R) (SI No. 1940); the Plant Protection Products Regulations (Amendments) 1997 (PPP[A]R) (SI No. 7) and the Plant Protection Products (Basic Conditions) Regulations 1997 (SI No. 189).

EC Directives

- EC Prohibition Directive 78/117/EEC and subsequent amendments.
- EC Authorisation Directive 91/414/EEC and subsequent amendments.
- EC Regulation 1107/2009.

Codes of Practice

- Protecting our Water, Soil and Air – A Code of Good Agricultural Practice for farmers, growers and land managers, available via www.defra.gov.uk/foodfarm/landmanage/cogap/documents/cogap090202.pdf.
- The Code of Practice for using Plant Protection Products (PB 11090) Defra, www.pesticides.gov.uk/safe_use.asp?id=64.
- The Code of Practice for using Plant Protection Products in Scotland, ISBN 0-7559-5093-3, www.scotland.gov.uk.
- Control of Substances Hazardous to Health (Fifth edition) HSE ISBN 978-07176-29817.
- Code of Good Practice for the Prevention of Environmental Pollution from Agricultural Activity, 2005, ISBN 0-7559-4106-3 available from The Scottish Environmental Protection Agency, www.sepa.org.uk.
- Storage of Approved Pesticides: Guidance for farmers and other professional users, 2004 (HSE AIS 16).
- Agricultural Pesticides, 1998 (HSE AIS 27).
- The Code of Practice for Suppliers of Pesticides to Agriculture, Horticulture and Forestry (Defra, PB 3529, 1998).

Other useful reference sources

- The UK Pesticide Guide 2012 (BCPC/CABI) (ISBN 978-1-780640-10-5).
- The Pesticide Manual 15th Edition (BCPC) (ISBN 1-901396-18-8).
- Using Pesticides (BCPC) (ISBN 1-901-396-088).
- Small Scale Spraying (BCPC) (ISBN 1-901-396-07X).
- Is your sprayer fit for work (B28268,

available free from www.scotland.gov.uk).

- Keeping pesticides out of water (B28267, available free from www.scotland.gov.uk).
- Pesticides and Integrated Farm Management (PB 9241, available free from Defra).
- Trees and field boundaries (a series of countryside management booklets available from DARDNI in Northern Ireland, www.ruralni.gov.uk).

Other publications referenced

- Willoughby, I., Clay, D. and Dixon, F. (2003). The effect of pre-emergent herbicides on germination and early growth of broad-leaved species used for direct seeding. Forestry 76: 83-94.
- Willoughby, I., Dixon, F. L., Clay, D. and Jinks, R. L. (2007). Tolerance of broad-leaved tree and shrub seedlings to pre-emergence herbicides. New Forest 34:1-12.

Glossaries

Glossary of weed names

	Common name	Latin name
A	Annual meadow-grass	*Poa annua* L.
B	Bindweed, black	*Fallopia convolvulus* L.
	Bindweed, lesser or field	*Convolvulus arvensis* L.
	Bittercress, flexuous	*Cardamine flexuosa* With.
	Bittercress, hairy	*Cardamine hirsuta* L.
	Bittercress, New Zealand	*Cardamine corymbosa* Hook. f.
C	Buttercup, creeping	*Ranunculus repens* L.
	Charlock	*Sinapsis arvensis* L.
	Chickweed, common	*Stellaria media* (L.) Vill.
	Chickweed, common mouse-ear	*Cerastium fontanum* Baurng. subsp. *triviale* (L.) Jalas (also *C. holosteoides*)
	Cleavers	*Galium aparine* L.
	Clover	*Trifolium* spp.
	Corn spurrey	*Spergula arvensis* L.
	Couch grass	*Elytrigia repens* (L.) Desv. ex Nevski
	Crane's bill, dove's foot	*Geranium molle* L.
D	Dandelion	*Taraxacum officinale* Weber
	Dead-nettle, red	*Lamium purpureum* L.
	Dock	*Rumex* spp.
F	Fat-hen	*Chenopodium album* L.
	Fleabane, Canadian	*Conyza canadensis* (L.) Cronq. (*Erigeron canadensis* L.)
	Fumitory, common	*Fumaria officinalis* L.
G	Groundsel	*Senecio vulgaris* L.
H	Hogweed	*Heracleum sphondylium* L.
	Horsetail, field	*Equisetum arvense* L.
K	Knotgrass, common	*Polygonum aviculare* L
L	Liverwort	*Marchantia polymorpha* L.
M	Mayweed	*Matricaria matricarioides* Less Porter, *Tripleurospermum inodorum* (L.) Vaarama
	Moss	*Funaria hygrometrica* Hedw.

	Common name	Latin name
N	Nettle, small (annual)	*Urtica urens* L.
	Nettle, stinging (perennial)	*Urtica dioica* L.
	Nightshade, black	*Solanum nigrum* L.
O	Orache, common	*Atriplex patula* L.
	Oxalis	*Oxalis* spp.
P	Pansy, field	*Viola arvensis* Murray
	Penny-cress, field	*Thlaspi arvense* L.
	Pearlwort, common	*Sagina procumbens* L.
	Poppy, common	*Papaver rhoeas* L.
R	Redshank	*Persicaria meculosa* Gray
	Rushes	*Juncus* spp.
S	Sallow, great	*Salix caprea* L.
	Scarlet pimpernel	*Anagallis arvensis* L.
	Shepherd's purse	*Capsella bursa-pastoris* (L.) Medicus
	Sorrel	*Rumex* spp.
	Sow-thistle, common	*Sonchus oleraceus* L.
	Speedwell, common	*Veronica officinalis* L.
T	Thistle, creeping	*Cirsium arvense* (L.) Scop
W	Wild-oat	*Avena* spp.
	Willow	*Salix caprea* L.
	Willowherbs	*Epilobium* spp.
Y	Yellow-cress, creeping	*Rorippa sylvestris* (L.) Besser

Glossary of terms

	Term	Definition
A	Annual	A plant completing its life cycle within 12 months.
	Axil	Joint between the leaf and stem.
B	Basal	At the base.
	Bracts	Small leaf like organs just below the flowers.
C	Capillary sand bed	A sand standing bed irrigated from pipes within or on the sand surface.
	Capsule	A dry fruit.
	Coir	A coconut husk fibre used as a growing medium.
	Colloid	A suspension of particles.
	Commodity substance	Chemicals which are predominantly used for non-pesticidal purposes.
	Contact	(Herbicide), having a direct action on the foliage.
	COSHH	Control of Substances Hazardous to Health Regulations 1994.
	Cotyledon	Seed leaves.
D	Deciduous	Looses leaves in winter.
E	EAMU	Extension of Authorisation and Consent for a Minor Use of a Plant Protection Product.
	Emulsifiable concentrate	Herbicide dissolved in an organic solvent together with emulsifying agents so that when added to water for use it forms a stable, milky, oil/water emulsion.
F	FEPA	Food and Environment Protection Act.
G	Glabrous	Without hairs.
H	Heading-back	Removal of the rootstock top growth above the cultivar bud.
L	Lanceolate	Spear shaped, narrowly oval and pointed.
	Linear	Almost parallel-sided.
	Liner	Young plant used for potting up.
	Lodging	(Granules), trapped in leaf axils, and crevices.
	LTAEU	Long Term Arrangements for Extension of Use.
M	Maiden	First year of growth from the bud or graft.

	Term	Definition
P	Perennial	A plant living for more than two years, usually flowering each year.
	Photo-degradation	Broken down by light.
	Phytotoxic	Damaging to plants.
	Pinnate	Leaf composed of more than three leaflets arranged in two rows along a common stalk.
	Post-emergence	After germination and appearance above soil level.
	Pre-emergence	Before or shortly after germination.
R	Residual	(Herbicide) having a persistent effect preventing weeds from germinating.
S	SOLA	Specific Off-Label Approval.
	Spikelet	Flower head with flowers arranged on a stem.
	Suspension concentrate	A flowable liquid containing finely divided herbicide mixed with surface-active agents dispersed in water.
T	Translocated	(Herbicide) travelling from the sprayed leaves to affect other parts.
W	Wettable powder	Finely divided herbicide, together with fillers and dispersing agent, able to provide a stable suspension when mixed with water for use.

Suppliers

Suppliers of herbicides

AaKo BV
PO Box 205
3830 AE Leusden
The Netherlands
T: 0031 3349 48494
F: 0031 3349 48044
W: www.aako.nl

AgChem Access Ltd
Pure House
64-66 Westwick Street
Norwich
Norfolk
NR2 4SZ
T: 01603 624413
F: 01759 371971
W: www.agchemaccess.com

Agrichem (International) Ltd
Industrial Estate
Station Road
Whittlesey
Cambridgeshire
PE7 2EY
T: 01733 204019
F: 01733 204162
W: www.agrichem.co.uk

Agrichem BV
Koopvaardijweg 9
4906 CV Oosterhout
Postbus 295
4900 AG Osterhout
Netherlands
T: 0031 1624 31931
F: 0031 1624 56797
W: www.agrichem.co.uk

Agriguard Ltd
Unit 1
Broomfield Business Park
Malahide
Co. Dublin
Ireland
T: 0035 3184 62044
F: 0035 3184 62489
W: www.agriguard.ie

Agriphar S.A
Rue de Renory 26/1
B-4102 Ougree
Belgium
T: 0032 4385 9711
F: 0032 4385 9749
W: www.agriphar.com

Agrotech Trading GmbH
Alte Landstrasse 15
D-88138 Sigmarszell
Germany
T: 0049 8389 92183
F: 0049 8389 92183

Albaugh UK Ltd
Manor Farm
Eddlethorpe
Malton
North Yorkshire
YO17 9QT

Barclay Chemicals Manufacturing Ltd
Damastown Way
Damastown Industrial Park
Mulhuddart
Dublin 15
Ireland
T: 0035 3181 12900
F: 0035 3182 24678
W: www.barclay.ie

BASF plc
Agriculture Division
PO Box 4
Earl Road
Cheadle Hulme
Cheshire
SK8 6QG
T: 0845 6022553
F: 0161 4852229
W: www.agricentre.co.uk

Bayer CropScience Ltd
230 Cambridge Science Park
Milton Road
Cambridge
Cambridgeshire
CB4 0WB
T: 01223 226500
F: 01223 426240
W: www.bayercropscience.co.uk

Bayer Environmental Science
230 Cambridge Science Park
Milton Road
Cambridge
Cambridgeshire
CB4 0WB
T: 01223 226680
F: 01223 226635
W: www.bayer-escience.co.uk

Belchim Crop Protection Ltd
Unit 1b
Fenice Court
Eaton Socon
St Neots
Cambridgeshire
PE19 8EP
T: 01480 403333
F: 01480 403444
W: www.belchim.com

Certis
1b Mills Way
Boscombe Down Business Park
Amesbury
Wiltshire
SP4 7RX
T: 01980 676500
F: 01980 626555
W: www.certiseurope.co.uk

Chemsource Ltd
5 Jupiter House
Calleva Park
Aldermaston
Reading
Berkshire
RG7 4NN
T: 0845 4594039

Chem-Wise Ltd
Westwood
Rattar Mains
Thurso
Caithness
KW14 8XW

Clayton Plant Protection (UK) Ltd
Head Office
Bracetown Business Park
Clonee
Co Meath
Ireland
T: 0035 3182 10127
F: 0035 3818 411084
W: www.cppltd.net

Dow AgroSciences Ltd
Latchmore Court
Brand Street
Hitchin
Hertfordshire
SG5 1NH
T: 01462 457272
F: 01462 426605
W: www.dowagro.com/uk

Du Pont (UK) Ltd
Crop Protection Products Department
Wedgwood Way
Stevenage
Hertfordshire
SG1 4QN
T: 01438 734450
F: 01438 734452
W: www.gbr.ag.dupont.com

Euro Chemicals s.r.o
S-77 Greater Kailash–1
New Delhi 110 048
India
T: 0091 1129 249543
W: www.eurochemicals.in

European Agrochemicals Ltd
Unit NR2
Hurst House
City Road
Radnage
Buckinghamshire
HP14 4DW
T: 01494 483728

FMC Chemical s.p.r.l
Boulevard de la Plaine 9
1050 Bruxelles, Belgium
T: 0032 2775 8311
W: www.fmccrop.com

Globachem NV
Leeuwerweg 138
B-3803 Sint-Truiden
Belgium
T: 0032 1178 5717
F: 0032 1168 1565
W: www.globachem.com

Goldengrass Ltd
PO Box 280
Ware
Hertfordshire
SG12 8XY
T: 01920 486253
F: 01920 485123

Greencrop Technology Ltd
Bracetown Business Park
Clonee
Co Meath
Ireland
T: 0035 3182 10127
F: 0035 3818 411084
W: www.cppltd.net

Hermoo Belgium NV
Brustem Industriepark
Lichtenberglaan 2045
B-3800 Sint Truiden
T: 0032 1168 6866
F: 0032 1167 1205
W: www.hermoo.be

Hermoo UK
21 Victoria Road
Wargrave
Berkshire
RG10 8AD
T: 01189 404 264
F: 01189 404 264

Hockley International Ltd
Hockley House
3 Longstone Road
Ashbrook Office Park
Manchester
M22 5LB
T: 0161 2097400
F: 0161 2097401
W: www.hockley.co.uk

Interfarm (UK) Ltd
Kingham's Place
36 Newgate Street
Doddington
Cambridgeshire
PE15 0SR
T: 01354 741 414
F: 01354 741 004
W: www.interfarm.co.uk

Inter-Trade Aalborg A/S
Halsvej 139
9310
Vodskov
Denmark
T: 0045 9825 7700
F: 0045 9825 7710

IT Agro Ltd
Salisbury House
London Wall
London
EC2M 5QQ

MAC-GmbH
Agriculture Products
Alte Landstrasse 15
D-88138 Sigmarszell
T: 0049 8389 92183
F: 0049 8389 92183
W: www.macgmbh.de

Makhteshim-Agan (UK) Ltd
Unit 16
Thatcham Business Village
Colthrop Way
Thatcham
Berkshire
RG19 4LW
T: 01635 860555
F: 01635 861555
W: www.mauk.co.uk

Monsanto (UK) Ltd
PO Box 663
Cambourne
Cambridge
Cambridgeshire
CB1 0LD
T: 01954 717575
F: 01954 717579
W: www.monsanto-ag.co.uk

Nomix Enviro, A division of Frontier Agriculture Ltd
Portland Building
The Grain Silos
Weyhill Road
Andover
Hampshire
SP10 3NT
T: 01264 388050
F: 01522 866176
W: www.nomix.co.uk

Novastar Link Ltd
23 Hunts Field Close
Lymm
Cheshire
WA13 0SS
T: 01925 753291

Nufarm UK Ltd
Wyke Lane
Wyke
West Yorkshire
BD12 9EJ
T: 01274 691234
F: 01274 691176
W: www.ag.nufarm.co.uk

Pan Agriculture Ltd
8 Cromwell Mews
Station Road
St Ives
Cambridgeshire
PE27 5HJ
T: 01480 467790
F: 01480 467041

Progreen Weed Control Solutions Ltd
Kellington House
South Fen Business Park
South Fen Road
Bourne
Lincolnshire
PE10 0DN
T: 01778 394052
W: www.progreen.co.uk

Pure Amenity Ltd
Unit 4A
Primrose Hill
Buttercrambe Road
Stamford Bridge
North Yorkshire
YO41 1AW
T: 0845 2574710

Rigby Taylor Ltd
Rigby Taylor House
Crown Lane
Horwich
Bolton
BL6 5HP
T: 01204 677777
F: 01204 677715
W: www.rigbytaylor.com

Standon Chemicals Ltd
48 Grosvenor Square
London
W1 2HT
T: 020 7493 8648
F: 020 7493 4219

Syngenta Crop Protection UK Ltd
CPC4
Capital Park
Fulbourn
Cambridge
Cambridgeshire
CB21 5XE
T: 01223 883400
F: 01223 493700
W: www.syngenta-crop.co.uk

Tronsan Ltd
Unit 1 and 2
Block B Broomfield Business Park
Malahide
Co Dublin
Ireland
T: 0035 3184 62044
F: 0035 3184 62489
W: www.agriguard.ie

United Agri Products Ltd
The Crossways
Alconbury Hill
Huntingdon
Cambridgeshire
PE28 4JH
T: 01480 418000
F: 01480 418010
W: www.uap.co.uk

United Phosphorous Ltd
Chadwick House
Birchwood Park
Warrington
Cheshire
WA3 6AE
T: 01925 819999
F:01925 8174255
W: www.upleurope.com

Suppliers of equipment for mechanical weed control

Edwards Farm Machinery Ltd
Clee Hill Road
Tenbury Wells
Worcestershire
WR15 8HL
T: 01584 810713
F: 01584 811124
W: www.efm-ltd.com

MJF
Chiddingfold Road
Dunsfold
Surrey
GU8 4PB
T: 01483 200711
F: 01483 200699
W: www.m-j-f.co.uk

Suppliers of mulches and pot-toppers

Mulches

Bark

Melcourt Industries Ltd
Boldridge Brake
Long Newnton
Tetbury
Gloucestershire
GL8 8RT
T: 01666 502711
W: www.melcourt.co.uk

Trefego substrates
c/o Fargro
Toddington Lane
Littlehampton
West Sussex
BN17 7PP
T: (01903) 721591
F: (01903) 730737
W: www.fargro.co.uk

Bio-top

Crustell
Handelsweg 36-38
6541 CT Nijmegen
The Netherlands
T: 0031 2469 62736
W: www.crustell.com

Cocoa-shell

William Sinclair Holdings plc
Firth Road
Lincoln
Lincolnshire
LN6 7AH
T: 01522 537561
W: www.william-sinclair.co.uk

Wool-moss pellets

Plant Care
Unit 2
Hill Top Farm
Nottingham Road
Melton Mowbray
Leicestershire
LE13 0NX
T: 01664 501146
W: www.plantcarelimited.co.uk

Pot-toppers

Fargro
Toddington Lane
Littlehampton
West Sussex
BN17 7PP
T: 01903 721591
F: 01903 730737
W: www.fargro.co.uk

Engrow BV
P.O. Box 6246
4000 HE Tiel
The Netherlands
T: 0031 3446 82528
F: 0031 3446 82427
W: www.engrow.nl

PG Horticulture
Progress Way
Mid Suffolk Business Park
Eye
Suffolk
IP23 7HU
T: 01379 873344
W: www.pghorticulture.co.uk

Application equipment (mulches)

Crustell
Handelsweg 36-38
6541 CT Nijmegen
The Netherlands
T: 0031 2469 62736
W: www.crustell.com

Hortec
Orchard Farm Nursery
Lower Tysoe
Warwickshire
CV35 0BU
T: 01295 688422
W: www.hortec.co.uk

Gal Systems Ltd
13 Park Drive
Cranleigh
Surrey
GU6 7DE
T: 01483 272958
F: 01483 272958
W: www.galsystems.co.uk

Mechanical Botanical Ltd
Pear Tree House
Ridgley Road
Chiddingfold
Surrey
Surrey
GU8 4QW
T: 01428 683505
F: 01428 682308
W: www.mechanical-botanical.com

Acknowledgements

The HDC would like to thank John Atwood and his colleagues at ADAS UK Ltd for compiling, writing and updating the information contained in the grower guide. The contribution that the late Margaret Scott (formerly HRI Efford) and John Adlam (Dove Associates) made to the original guide is gratefully acknowledged.

Photographic credits

Front cover

First insert image courtesy of ADAS UK Ltd. and second insert image courtesy of Heinrich Lösing.

Container-grown nursery stock – weed profiles

All images courtesy of HDC/Nigel Caitlin except:

- Third image of common sow-thistle courtesy of ADAS UK Ltd.
- Third image of willowherb courtesy of ADAS UK Ltd.

Field-grown nursery stock – weed profiles

All images courtesy of ADAS UK Ltd except:

- All images of annual meadow-grass, common chickweed, groundsel and the first and second images of willowherb courtesy of HDC/Nigel Caitlin.
- First and second images of dove's-foot crane's-bill courtesy of The Food and Environment Agency (Fera), Crown Copyright.
- Second image of field horsetail courtesy of Frank Lane Picture Agency Ltd.
- First and second images of creeping yellow-cress courtesy of Frank Lane Picture Agency Ltd.

Examples of herbicide damage

Images of damage symptoms from clopyralid, glyphosate, isoxaben, lenacil and metam-sodium courtesy of Heinrich Lösing.

Image of damage symptom from diquat courtesy of Dove Associates.

Image of damage symptom of metazachlor courtesy of ADAS UK Ltd.

Nutrient deficiencies that could be mistaken for herbicide damage

All images courtesy of ADAS UK Ltd.

AHDB Agriculture & Horticulture DEVELOPMENT BOARD

HDC is a division of the Agriculture and Horticulture Development Board (AHDB).

£50.00
where sold

HDC **Horticultural Development Company**

Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T: 024 7669 2051
E: hdc@hdc.ahdb.org.uk
Twitter: @HDCtweets

www.hdc.org.uk