Forestry Commission

Forest Nursery Herbicides

David Williamson, Bill Mason, John Morgan and David Clay

Technical Paper 3

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Summary

Information is given on the use of forest nursery herbicides. Much of this information is based on the results of Forestry Commission experiments. A brief description of the types of herbicides is given followed by information on the various herbicides which can be used at the different stages of forest nursery stock production.

Forest Nursery Herbicides

Introduction

This Technical Paper is a revision of Occasional Paper 22 (1989) and includes information on new herbicide products which now appear safe for use in the forest nursery.

In the text, herbicides are presented according to the phase of the crop cycle, i.e. seedbed or transplants/ undercuts. Within a given phase, herbicides are listed and discussed by the chemical active ingredient (a.i.). Where rates of herbicide are given, these refer to the rate of product (litre (l) or kilogram (kg)) to be applied **per treated hectare.** Representative products with which Forestry Commission researchers are familiar are also noted. Appropriate herbicides are listed according to stage of crop cycle and weed emergence in Table 1. Information on the choice of herbicides according to weed species present is given in Tables 2 and 3. In both cases, managers should then consult the main body of the text for information on herbicides that seem suitable.

All the products mentioned in this Technical Paper are approved under the Control of Pesticide Regulations 1986 unless otherwise stated. However, many are not yet approved for use in forest nurseries. The use of such products is covered by the long-term interim 'off-label' arrangements. These arrangements will continue in force until the end of 1994. They allow products approved for use on any growing crop to be used on non-edible crops and plants grown in forest nurseries. In all cases, those uses of a herbicide which are not specified on the approved product label are at user's own risk. This means that the manufacturer cannot be held responsible for any adverse effects on crops or for any failure to control weeds. However, employers and operators must still use the product in accordance with the product label recommendations. Where such uses are referred to they are identified by an asterisk (*).

Caution

All recommendations in this Technical Paper are based on small-scale experiments carried out at a limited number of sites in only a few seasons. Nursery managers must determine the approval status of herbicide products before using them in their own nursery. They should also conduct limited trials with a new herbicide before adopting it on a commercial scale.

Principles of weed control

In all nursery regimes, the aim must be to start with weed-free ground and to maintain this throughout the life of the crop. Regular inspection of the entire nursery area is vital to check for any signs of weed growth. Any weeds must be correctly identified and controlled as soon as possible. This applies equally to the cropped area, fallow ground and unproductive areas round buildings and fence lines. The use of a fallow period between crops is a sensible precaution to allow nursery managers to control weed populations that may have built up during the production cycle.

Description of herbicide action

There are basically two types of herbicide: soil-acting residual and foliar-acting. Some herbicides are both soil- and foliar-acting but generally their activity is biased towards one of these modes of action.

Managers should remember that herbicide efficacy is influenced by weather conditions, e.g. residual herbicides should be applied to moist soil to aid incorporation; do not apply herbicides, particularly foliar-acting types, in hot sunny conditions because of the risk of crop damage.

Soil-acting residual herbicides

Residual herbicides should be applied to weed-free soil which has a fine tilth and is free from clods. However, if small weeds are present, products which also have foliar activity must be chosen (see Table 3). To be activated, soil-acting herbicides require moisture in the soil and many (particularly those rapidly degraded by sunlight) need to be incorporated immediately after application by irrigation with 10-15 mm of water. The length of time residual herbicides remain effective varies, depending on the chemical in use, soil type and weather, particularly rainfall, sunlight and temperature.

Foliar-acting herbicides

These herbicides are absorbed through the point of contact on the leaf and stem and are independent of the condition of the soil. These herbicides give better weed control if applied when the target weed species is actively growing. Most foliar-acting herbicides require 6 hours of dry weather following application to be absorbed into the plants. Rainfall before full absorption has occurred will result in a reduced level of weed control.

Using this guide

1. Identify potential or actual weed problem.

2. Refer to Table 1 and select the appropriate stage of crop cycle (i.e. fallow, seedbed, transplant lines/second year undercuts, etc.).

3. Within the selected stage of crop cycle choose the appropriate column depending upon the growth stage of weed(s) and crop.

4. Identify suitable herbicides from the column.

5. Read the herbicide entries in the main text carefully, checking suitability for crop species and stage of growth.

6. Refer to Table 2 when treating weeds pre-emergence and Table 3 when treating weeds post-emergence to determine if the chosen herbicide(s) are effective against the problem weed(s).

7. If the herbicide is effective, check the main text for detailed recommendation.

8. If the chosen herbicide may damage the crop, consider the use of an inter-row spray or mechanical weeding.

9. If there is no information about a particular weed species or no herbicide seems suitable, seek further advice.

The information contained in Tables 2 and 3 has been drawn from the product labels and is not exhaustive.

Herbicide resistance

Nursery managers are strongly advised against using the same herbicide repeatedly over a number of years on the same area of ground. This can lead to two main problems:

1. the development of herbicide-resistant strains of particular weed species, e.g. triazine-resistant groundsel and willow-herb;

2. the development of soil microflora which rapidly degrade the chemical active ingredient, thus reducing the persistence of soil-acting herbicides.

It is therefore strongly recommended that herbicides are used in rotation, e.g. by using alternative products perhaps one year in four.

Identification of herbicide-resistant weeds

Growers with persistent weed species can assess whether these weeds are resistant to specific herbicides used in their nursery. The following test is simple and informative:

1. Fill two seed trays with nursery soil.

2. Sow one tray with seed collected from persistent weeds from the nursery.

3. Sow the remaining tray with seed collected from a wild source of the same weed (i.e. that has never been sprayed). Label trays.

4. Allow seed to germinate and grow to the stage where problems with control are experienced. This may be immediately after sowing.

5. Place trays on the ground and apply the herbicide to be tested as a single pass. The sprayer should be calibrated to match the swath width and forward speed for the trial.

6. If the wild seed source is killed and the nursery source unaffected then herbicide resistance is likely.

7. If both seed sources are damaged to the same extent then there is a need to examine (a) the choice of herbicides that are used in the nursery and (b) the method of application to explain the lack of efficacy of nursery treatments.

Weed control in seedbeds

Pre-sowing treatments

Soil sterilisation

This usually takes place in the late summer – early autumn of the year prior to sowing and controls many soil pests (nematodes, fungi) as well as weeds and weed seed. Sterilants will usually also improve the growth of trees.

With both soil sterilants, it is important to aerate the soil and release all the sterilant residues prior to sowing. A recommended test for the presence of residues prior to sowing is to grow cress in sealed jars containing samples of sterilised soil. If the cress fails to grow, then further cultivation is required to release the sterilant.

Dazomet (1)

Approved product *Basamid* 98-99% a.i. Rate 380-570 kg ha^{-1} depending on soil type. The high rate is used only on heavy soils.

Must be incorporated when soil temperature is at least 7 °C. Should be incorporated by rotavation and sealed in by rolling or polythene sheeting. Wait at least 4 weeks before cultivating soil to release gas. If dazomet is applied in the autumn it is normal to wait until the spring before releasing the gas.

Methyl bromide (2)

Contains 98% methyl bromide + 2% chloropicrin as a warning odourant tear gas. Rate 300-500 kg ha^{-1}.

Subject to the 1982 Poisons Act and the 1972 Poisons Rules and can only be applied by licensed contractors.

Soil temperature should be at least 8 °C at 15-20 cm depth. Treatment period 48-96 hours depending on temperature. Aerate soil for 7-21 days before sowing.

Stale seedbed technique

This technique can be carried out either before or after seedbeds have been formed. A fine tilth is created which allows the germination of weeds; these are then killed by further cultivation or by foliar-acting herbicides.

	Rate for small weeds	Rate for large/ established weeds
Glufosinate-ammonium (3)		
Approved product *Challenge* 180 g l^{-1} a.i.	3.0 l ha^{-1}	5.0 l ha^{-1}
Glyphosate (4)		
Approved product *Roundup* 360 g l^{-1} a.i.	1.5 l ha^{-1}	4.0 l ha^{-1}

Paraquat: approved product *Gramoxone* is available and has been recommended previously; current recommendations (3, 4) offer the same efficacy of weed control while providing greater operator safety.

Post-sowing treatments

Seedbed pre-tree emergence

Seeds of small-seeded broadleaved species and conifers are normally sown on to the surface of raised seedbeds and covered with 2-3 mm of grit. Pre-emergence herbicides are then applied immediately after sowing before crop germination. Large-seeded broadleaves such as oak, beech and sweet chestnut are usually drilled into seedbeds and then covered with at least 25 mm of soil. Such species are therefore usually more tolerant of pre-emergence herbicides.

Chlorthal-dimethyl (5)

Approved product *Dacthal** 750 g kg^{-1} a.i. Rate 6.0 kg ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Apply immediately post-sowing. Tolerated by a large number of tree species but not pine. Does not control germinated weeds since it has no foliar activity.

Diphenamid (6)

Approved product *Enide 50W* 500 g kg^{-1} a.i. Rate 8.0 kg ha^{-1}.

Tolerated by a wide range of tree species but alder, birch and occasionally larch are damaged by pre-emergence application. Does not control germinated weeds since it has no foliar activity. Recently withdrawn by manufacturer but stocks available from distributors.

Diphenamid in mixture with chlorthal-dimethyl (7)

Approved products
Enide 50W 500 g kg^{-1} a.i. Rate 8.0 kg ha^{-1}.
Dacthal 750 g kg^{-1} a.i. Rate 6.0 kg ha^{-1}.

In mixture these two products control a wider range of weeds and give greater persistence than diphenamid on its own.

Glufosinate-ammonium (8)

Approved product *Challenge* 150 g l^{-1} a.i. Rate 3.0 l ha^{-1}.

Can be used with care to clean up seedbeds post-sowing provided shallowly or surface sown tree seed has not started to germinate. Check that no seed radicles are present before deciding to spray. Seedbeds containing large seeded broadleaves which are drilled and covered with at least 25 mm of soil can be sprayed as long as the shoots of trees have not emerged.

Napropamide (9)

Approved product *Devrinol* 450 g l^{-1} a.i. Rate 2.2 l ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Apply immediately post-sowing. Tolerated by coniferous species. Does not control germinated weeds since it has no foliar activity. This product is rapidly broken down by sunlight and is therefore best applied between November and March unless irrigated into the soil with at least 25 mm of water.

Simazine (10)

Approved product *Gesatop 500FW* 500 g l^{-1} a.i. Rate 4.0 l ha^{-1}.

Treat only large-seeded broadleaved species, i.e. oak, beech and sweet chestnut, which have been drilled into seedbeds. Application should be immediately after drilling. Does not generally control germinated weeds due to lack of foliar activity.

Seedbed post-tree emergence

Diphenamid (11)

Approved product *Enide 50W* 500 g kg^{-1} a.i. Rate 8.0 kg ha^{-1}.

Can be applied to all species post-emergence, including birch and alder. Apply when first true needles or leaves are fully extended. Stunting can occur if applied earlier. Subsequent application can be made at 6-weekly intervals. Recently withdrawn by manufacturer but stocks available from distributors.

Propyzamide (12)

Approved products
*Kerb 50W** 500 g kg^{-1} a.i. Rate 3.0 kg ha^{-1}.
*Kerb flowable** 400 g l^{-1} a.i. Rate 3.75 l ha^{-1}.

Tolerated by all commonly grown forest species and particularly useful on standover beds when applied at the end of the first growing season. Apply November to December (January: north of a line from Aberystwyth to London). For crop safety reasons propyzamide should not be used within 6 months of an application of simazine or atrazine. It is important to ensure that this herbicide is removed from the tree foliage and into the soil by irrigation to prevent tree damage.

Simazine (13)

Approved product *Gesatop 500FW* 500 g l^{-1} a.i. Rate 2.0 l ha^{-1}.

Only apply to dormant second year seedbeds when plants are greater then 5 cm tall. All conifer species except Norway spruce may be treated. Do not treat within 2 weeks of undercutting, i.e. allow soil to settle around the roots of trees.

Seedbed post-tree emergence: repeat low dose regime

As a result of research, it now appears possible to use a wider spectrum of herbicides at low doses when applied at regular intervals after crop emergence to maintain weed-free conditions.

Apply the following herbicides (14, 15, 16 and 17) in a repeat low dose regime after an initial pre-emergent application. The first application should be made as soon as trees have reached the first true leaf/needle stage. Treatments should be repeated at 6-weekly intervals.

These treatments have been successfully screened for three seasons over Sitka spruce, Japanese larch, common alder and birch.

Metamitron (14)

Approved product *Goltix WP** 700 g kg^{-1} a.i. Rate 1.7 kg ha^{-1}.

Limited information on tolerance of crop species.

Metazachlor (15)

Approved product *Butisan S** 500 g l^{-1} a.i. Rate 1.25 l ha^{-1}.

Limited information on tolerance of crop species.

Napropamide (16)

Approved product *Devrinol** 450 g l^{-1} a.i. Rate 1.1 l ha^{-1}.

Limited information on tolerance of crop species.

Propyzamide (17)

Approved products
*Kerb 50W** 500 g kg^{-1} a.i. Rate 1.5 kg ha^{-1}.
*Kerb flowable** 400 g l^{-1} a.i. Rate 1.87 l ha^{-1}.

Limited information available on tolerance of crop species.

Weed control in transplant lines and second year undercuts

Soil-acting herbicides with no or limited post-emergence activity on weeds

Residual herbicides are widely used in transplant lines and second year undercut beds. In the case of transplants these are normally applied immediately after lining out to ground which is free from weeds, and repeated as necessary. When a precision sowing and undercutting regime is in operation, residual herbicides should be applied during the first winter dormant period. Many of the residual herbicides listed do not control germinated weeds and therefore if good weed control is to be achieved they must be applied before weeds emerge. It is therefore important to adopt an effective weed control regime on first year precision sown seedbeds to ensure the ground is clean when the second year residual herbicides are applied. Depending on the prevailing conditions, these can be applied any time from when trees become dormant in the autumn to just before bud burst in the spring. When applying soil-acting herbicides to undercut stock, application must only take place after soil has settled following undercutting or wrenching. Soil disturbance must be kept to a minimum when these operations are carried out. This is because of the risk of herbicides coming into direct contact with tree roots.

The herbicides listed (18-32) either have no foliar activity or only control weeds in an early post-emergent stage.

Decision chain when using soil-acting herbicides

1. Where lining out is being considered, cultivate to produce a fine, firm tilth.

2. Identify potential weed problems.

3. Match weed spectrum to a suitable herbicide or mixture of herbicides.

4. Consider the suitability of the herbicide for the crop species and stage of growth.

5. Apply the herbicide to soil which has a firm, fine tilth. Soil should be moist before application and herbicides should be incorporated with irrigation (up to 10-15 mm of water) immediately after application.

Atrazine (18)

Approved product *Gesaprim 500FW** 500 g l^{-1} a.i. Rate 4.0 l ha^{-1}.

Use on conifer transplant lines. Normally applied in spring prior to flushing. Use half rate on sensitive species (e.g. Norway spruce, larch and Western hemlock). No control of triazine-resistant weeds. Mobile in the soil and can be washed into low lying areas causing local overdosing.

Chlorthal- dimethyl (19)

Approved product *Dacthal** 750 g kg^{-1} a.i. Rate 6.0 kg ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Tolerated by a wide range of tree species.

Chlorbufam + chloridazon (20)

Approved product *Alicep** 250 + 200 g kg^{-1} a.i. Rate 4.5 kg ha^{-1}.

Dormant Sitka spruce have been treated successfully immediately after lining out and in established transplant lines. Limited information on other forest tree species. Withdrawn by manufacturer but stocks may be available from distributors.

Cyanazine (21)

Approved product *Fortrol** 500 g l^{-1} a.i. Rate 4.0 l ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Tolerated by a wide range of tree species, but damage can occur if trees have started to flush or are in active growth.

Diphenamid (22)

Approved product *Enide 50W* 500 g kg^{-1} a.i. Rate 10.0-12.0 kg ha^{-1}.

A wide range of tree species are tolerant. Does not control germinated weeds. Repeat treatments can be applied at the above rate at 6-weekly intervals. Recently withdrawn by manufacturer but stocks available from distributors.

Isoxaben (23)

Approved product *Flexidor** 500 g l^{-1} a.i. Rate 0.25 l ha^{-1}.

Controls a wide range of broadleaved weeds but has no activity on grass weeds. Should not be used on areas that will be used for seedbeds next season due to strong residual activity. Land must be mouldboard ploughed at least 20 cm depth before the following crop.

Lenacil (24)

Approved product *Venzar** 800 g kg^{-1} a.i. Rate 2.2 kg ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Tolerated by a wide range of tree species.

Metamitron (25)

Approved product *Goltix WG** 700 g kg^{-1} a.i. Rate 5 kg ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Tolerated by a wide range of tree species.

Metazachlor (26)

Approved product *Butisan S* 500 g l^{-1} a.i. Rate 2.5 l ha^{-1}.

Controls a range of grass and broadleaved weeds. Tolerated by a wide range of tree species.

Napropamide (27)

Approved product *Devrinol* 450 g l^{-1} a.i. Rate 9.0 l ha^{-1}.

Broken down by sunlight so best applied November-March unless irrigated into the soil with at least 25 mm of water. Apply immediately after lining out. Has proved satisfactory on most conifers, but only limited information is available for broadleaves.

Napropamide in mixture with simazine

Approved products
Devrinol 450 g l^{-1} a.i. Rate 3.5 l ha^{-1}.
Gesatop 500FW 500 g l^{-1} a.i. Rate 1.0 l ha^{-1}.

Crop tolerance as napropamide but care is needed on simazine-sensitive tree species.

Oryzalin (28)

Approved product *Surflan* 480 g l^{-1} a.i. Rate 4.5-6.0 l ha^{-1}.

At the time of writing, product temporarily unavailable while the manufacturers gather information to satisfy the Pesticide Safety Division. Seek manufacturer's advice on approval status before use.

Controls a range of weed species. Tolerated by a wide range of tree species.

Oxadiazon (29)

Approved product *Ronstar* 250 g l^{-1} a.i. Rate 4.0 or 8.0 l ha^{-1}.

Rate depends on the weeds to be controlled. Only apply in late winter before buds start to swell. Contact with young leaves and shoots must be avoided. This herbicide has almost entirely soil activity but will control weeds very early post-emergent before the first true leaf stage. Tolerated by most conifers (e.g. spruces, pines and larches) but there is only limited information on broadleaves. However, tree tolerance is greatly increased if the above instructions are adhered to.

Pendimethalin (30)

Approved product *Stomp 400 SC** 400 g l^{-1} a.i. Rate 6.0 l ha^{-1}.

Controls a wide range of grass and broadleaved weeds. Tolerated by a wide range of tree species.

Propyzamide (31)

Approved products
Kerb 50W 500 g kg^{-1} a.i. Rate 3.0 kg ha^{-1}.
Kerb flowable 400 g l^{-1} a.i. Rate 3.75 l ha^{-1}.

Apply November to December (January: north of a line from Aberystwyth to London). Treat all common forest tree species. For crop safety reasons propyzamide should not be used within 6 months of an application of simazine or atrazine. In mild autumns application should be delayed until the weather has turned cold and wet.

Simazine (32)

Approved product *Gesatop 500FW* 500g l^{-1} a.i. Rate 2.0-4.0 l ha^{-1}.

All conifer transplant lines may be treated as well as all commonly planted deciduous species except ash. Does not control germinated or triazine-resistant weeds. Higher rate is used on heavier soils. Soils must be moist and sufficiently compacted to prevent herbicide washing down to the rooting zone of trees. Use half rate on sensitive species (e.g. larch).

Herbicides with foliar activity

When the control of weeds after they have emerged is the objective, herbicides with foliar activity are usually required. It is vital to correctly identify the weed problem and select a herbicide which will control the relevant weeds at the appropriate stage of growth. As weeds become larger, the choice of effective herbicides diminishes; it is therefore important to carry out a detailed inspection of the nursery on a regular basis so that weeds can be controlled soon after emergence.

Alloxydim-sodium (33)

Approved product *Clout* 750 g kg^{-1} a.i. Rate 1.25-3.0 kg ha^{-1}.

Only effective against grass weeds (useful on couch) but annual meadow grass, red fescue and all broadleaved weeds are resistant. When controlling annual grasses, use 1.25 kg ha^{-1} rate. This will be effective from the 3 true leaf stage (when there is sufficient foliage to take up the herbicide) to the start of tillering. Perennial and rhizomatous grasses should be treated at the 3-4 true leaf stage with 2.5-3.0 kg ha^{-1}. Best results are obtained when applied in cool, mild weather when there is adequate soil moisture and weeds are in active growth. All forest trees can be treated. Recently withdrawn by manufacturer but stocks may be available from distributors.

Atrazine (34)

Approved product *Gesaprim 500FW** 500 g l^{-1} a.i. Rate 4.0 l ha^{-1}.

Use on conifer transplant lines. Normally applied in spring prior to flushing. Use half rate on sensitive species (e.g. Norway spruce, larch and Western hemlock). No control of triazine-resistant weeds. Mobile in the soil and can be washed into low lying areas causing local overdosing.

Clopyralid (35)

Approved product *Dow shield** 200 g l^{-1} a.i. Rate 0.5 l ha^{-1}.

Controls a narrow weed spectrum very effectively.

Tolerated by a wide range of tree species when they are dormant. Many tree species have been successfully over sprayed during the growing season once the extremely tender early growth has hardened. Larch can exhibit severe twisting of needles but eventually grows out of this transient damage. Douglas fir shows the same symptom to a lesser extent. Some broadleaved species exhibit transient damage as curling of margins of leaves, particularly alder and beech.

Cyanazine (36)

Approved product *Fortrol** 500 g l^{-1} a.i Rate 4.0 l ha^{-1}.

Controls a wide range of grass and broadleaved weeds early post-emergent. Tolerated by a wide range of tree species, but damage can occur if trees have started to flush or are in active growth.

Clopyralid + cyanazine (37)

Approved product *Coupler SC** 350 + 60 g l^{-1} a.i. Rate 1.0 l ha^{-1}.

Controls a wide range of grass and broadleaved weeds early post-emergent. Tolerated by a wide range of tree species when applied before trees start to flush. Withdrawn by manufacturer, limited stocks may be available through distributors.

Fluazifop-P-butyl (38)

Approved product *Fusilade 5** 125 g l^{-1} a.i. Rate 1.5-3.0 l ha^{-1} + Agral 0.1% of final spray volume.

Only effective against grass weeds, but annual meadow grass, fescue spp. and all broadleaved weeds are resistant. When controlling annual grasses (black-grass, barren (sterile) brome), volunteer cereals and wild oats use the 1.5 l ha^{-1} rate. This will be effective from the 2 true leaf stage (when there is sufficient foliage to take up the herbicide) to the fully tillered stage. Perennial and rhizomatous grasses should be treated at the 4 true leaf stage with 3.0 l ha^{-1}. All forest trees can be treated. This product is not approved for application through hand-held equipment.

Metamitron (39)

Approved product *Goltix WG** 700 g kg^{-1} a.i. Rate 5.0 kg ha^{-1}.

Controls a wide range of grass and broadleaved weeds but only at the cotyledon stage post-emergent. Tolerated by a wide range of tree species.

Metazachlor (40)

Approved product *Butisan S* 500 g l^{-1} a.i. Rate 2.5 l ha^{-1}.

Controls a limited range of grass and broadleaved weeds early post-emergent. Tolerated by a wide range of tree species, but pine can be damaged if treated when in active growth before candles have hardened.

Propyzamide (41)

Approved products
Kerb 50W 500 g kg^{-1} a.i. Rate 3.0 kg ha^{-1}.
Kerb flowable 400 g l^{-1} a.i. Rate 3.75 l ha^{-1}.

Apply November to December (January: north of a line from Aberystwyth to London). Controls a range of broadleaved weeds early post-emergent and a wide range of grasses up to an advanced stage of growth. Treat all common forest tree species. For safety reasons propyzamide products should not be used within 6 months of an application of simazine or atrazine.

The two herbicides listed below can be used as a directed spray, avoiding all contact with the crop, to control emerged and established weeds in transplant lines.

Glufosinate-ammonium (42)

Approved product *Challenge* 150 g l^{-1} a.i. Rate 3.0-5.0 l ha^{-1}.

Glyphosate (43)

Approved product *Roundup* 360 g l^{-1} a.i. Rate 1.5-4.0 l ha^{-1}.

Paraquat: approved product Gramoxone is available and has been recommended previously; current recommendations (42, 43) offer the same efficacy of weed control while offering greater operator safety.

Weed control in fallow areas

The fallow period in a forestry nursery rotation provides an opportunity for controlling deep-rooted weeds by a combination of cultivation and chemical control. Certain perennial weeds cannot be controlled in growing crops where effective herbicides do not offer sufficient crop safety (e.g. *Equisetum* spp. and heather). Repeat cultivation and application of herbicides (44, 45, 46) may be necessary to achieve adequate control.

Glufosinate-ammonium (44)

Approved product *Challenge* 150 g l^{-1} a.i. Rate 3.0-5.0 l ha^{-1}.

Glyphosate (45)

Approved product *Roundup* 360 g l^{-1} a.i. Rate 1.5-4.0 l ha^{-1}.

Repeat applications combined with intervening cultivation can be particularly useful against deep-rooting weeds such as *Equisetum* spp.

Sodium chlorate (46)

Approved product *Atlacide Soluble Powder* 580 g kg^{-1} a.i. Rate 375-500 kg ha^{-1}.

Should only be used in extreme circumstances to control persistent weeds, e.g. *Equisetum* spp. At least 6 months should elapse between treatment and sowing or lining out. A cress test should be carried out before any crop is planted on the treated area.

Paraquat: approved product Gramoxone is available and has been recommended previously; current recommendations (44, 45) offer the same efficacy of weed control while offering greater operator safety.

BEFORE ANY HERBICIDE IS USED READ THE LABEL.

IT CARRIES FULL INSTRUCTIONS FOR USE AND FOR THE PROTECTION OF THE OPERATOR AND THE ENVIRONMENT.

Table 1. Guide to the use of herbicides at different stages of the crop cycle

Fallow	Seedbed Pre-sowing		Seedbed Post-sowing				Transplant lines/second year undercuts			
	Pre-emergence weeds	Post-emergence weeds	Before weed emergence		After weed emergence		Pre-emergence weeds		Post-emergence weeds	
			Pre-emergence crop	Post-emergence crop	Pre-emergence crop	Post-emergence crop	Dormant crop	Active crop	Dormant crop	Active crop
Glufosinate-ammonium[44] Glyphosate[45] Sodium chlorate[46]	Dazomet[1] Methyl bromide[2]	Glufosinate-ammonium[3] Glyphosate[4]	Chlorthal-dimethyl[5,7 b] Diphenamid[6,7 b] Napropamide[9] Simazine[10]	Diphenamid[11] Metamitron[14 c] Metazachlor[15 c] Napropamide[16 c] Propyzamide[12,17 c] Simazine[13]	Glufosinate-ammonium[8]	Propyzamide[12]	Atrazine[18] Chlorthal-dimethyl[19] Chlorbufam + chloridazon[20] Cyanazine[21] Diphenamid[22] Isoxaben[23] Lenacil[24] Metamitron[25] Metazachlor[26] Napropamide[27 b] Oryzalin[28] Oxadiazon[29] Pendimethalin[30] Propyzamide[31] Simazine[32]		Alloxydim-sodium[33] Atrazine[34] Clopyralid[35] Cyanazine[36] Clopyralid + cyanazine[37] Fluazifop-P-butyl[38] Metamitron[39] Metazachlor[40] Propyzamide[41] Glufosinate-ammonium[42 a] Glyphosate[43 a]	Alloxydim-sodium[33] Clopyralid[35] Clopyralid + cyanazine[37] Fluazifop-P-butyl[38] Propyzamide[41] Glufosinate-ammonium[42 a] Glyphosate[43 a]

Notes **The numbers in this table refer to the herbicide entries in the main text. You are recommended to read these carefully.**

[a] Use as a directed spray avoiding all contact with crop trees.

[b] Can be used in mixture; see main text.

[c] Only under repeat low dose regime; see main text.

Table 2. Susceptibility of common forest nursery weeds to selective herbicides before weed emergence

Active ingredients	Atrazine	Chlorbufam + choridazon	Chlorthal-dimethyl	Cyanazine	Diphenamid	Diphenamid with chlorthal-dimethyl	Isoxaben	Lenacil	Metamitron	Metazachlor	Napropamide	Napropamide with simazine	Oryzalin	Oxadiazon	Pendimethalin	Propyzamide	Simazine
Weeds																	
Annual meadow grass	S	MS	MS	S	S	S	R	S	S	S	S	S	S	S	S	S	S
Bitter cress, hairy					S	S	S				MR	MS	S	S			
Black bindweed	MS	S	MS	S		MS		S	MS	MS	S	S		S	S	S	MS
Black nightshade	S		MS	MS	R	MS		R	MS		R	S	MS	S	S	S	S
Broadleaved dock								S	S							S	
Chamomile spp.	S				MS	MS	S	S	S					S	S		S
Charlock	S	S	MR	S			S	S	S	MR	R	S		S			S
Cleavers	MR	S	R	MR			MS	R		MS	S	S		S	S	S	MR
Common chickweed	S	S	S	S	S	S	S	S	S	S	S	S	S		S	S	S
Common fumitory	MS	MS	R	MS	R	R	S	S	S	R	S	S	S	S	S	MS	MS
Common hemp nettle	S			S			S		S	MR	S	S					S
Common poppy	S			S			S	S	S	S	S	S			S		S
Corn buttercup	R			S			S	S							S		
Corn marigold	S		R	S			S	S	S	S	R	S			S		S
Dead nettle, red	S		MS	S		MS	S	MS	S	S	S	S	S	S	S		S
Fat hen	S	S	S	MS	MS	S	S	S	S	MS	S	S	S	S	S	S	S
Field pansy	MS	S	S	MS		S	S	R	S	MR	MS	MS	S		S		MS
Field penny cress	S	S	R		S	S		S	S	R	R	S					S
Forget-me-not, field	S	S		S			S	S	S	S			S		S	S	S
Groundsel	S	S	R	S	S	S	S	MS	S	S	S	S	MS	S		R	S
Henbit dead nettle	S	S		S		S		MS	S	S	S	S	S	S	S		S
Knotgrass	MR	S	S	MS	MS	S	S	S	S	R	MS	MS	S	S	S	S	R
Mayweed	S	S	R	S	MS	MS	S	S	S	S	S	S	S	S	S	R	S
Mercury, annual	S		MS			MS											S
Mustard	S		R	S				S									S
Orache, common	MS			S	MS	MS	S	S	S		S	S		S	S		MS
Pale persicaria	MS			S	MS	MS		S	S		S	S					
Parsley-piert	S			S			S			S	R	S			S		S
Pineapple weed	S				MS	MS	S	S	S	S				S	S		S
Plantain	S																S
Radish, wild	S	S	R	S			S	S	S		MR	S		S			S
Redshank	MS	S	MR	S	MS	MS	S	S	S	MS	MS	MS		S	S	S	MS
Scarlet pimpernel	S	MS		S			S	S	S		R	R			S	R	S
Shepherd's purse	S	S	R	S	S	S	S	S	S	S	MR	S	S	S	S	MS	S
Small nettle	S	S	S	S	S	S	S	MS		MS	S	S	S	S	S	S	S
Smooth sow thistle	S	S				S		S			S	S	S	S	S		S
Sorrel, sheep's	MR				S	S			S		S	S	MS			S	
Speedwells	T	S	S	S	S	S	S	MS	S	S	S	S	S	S	S	S	MS
Spurrey, corn	MS				S	S	S	S	S	MS	S	S		S		S	MS
Thale-cress	S						S										
Volunteer cereals	MS																S
Volunteer oil seed rape							S			MR					S		S
Willow-herb	R				S	S					MS	MS	S	S		R	MS

Key S: susceptible
MS: moderately susceptible
MR: moderately resistant
R: resistant
Blank space in table indicates not tested

Note Sodium chlorate controls most weeds pre-emergence.

Table 3. Susceptibility of common nursery weeds to selective herbicides after weed emergence.
This shows the latest growth stage when weeds may be treated successfully

Active ingredients	Alloxydim-sodium	Atrazine	Chlorbufam + chloridazon	Clopyralid	Cyanazine	Cyanazine + clopyralid	Fluazifop-P-butyl	Metamitron	Metazachlor	Propyzamide
Broadleaved weeds										
Bitter cress, hairy	R						R			
Black bindweed	R	50 mm	C	2 ETL	100 mm	2 ETL	R			2 ETL
Black nightshade	R	100 mm			100 mm		R	C		2 ETL
Broadleaved dock	R						R	C		2 ETL
Chamomile spp.	R	100 mm		2 ETL			R			
Charlock	R	100 mm	C		6 ETL	4 ETL	R	C		
Cleavers	R		C				R		4 ETL	2 ETL
Common chickweed	R	100 mm	C		100 mm	2 ETL	R	C		2 ETL
Common fumitory	R	50 mm	C		1 ETL	2 ETL	R	C		2 ETL
Common hemp nettle	R	100 mm			100 mm		R	C		
Common poppy	R	100 mm					R	C		
Corn buttercup	R	R					R			
Corn marigold	R	100 mm		6 ETL	2 ETL		R	C		
Dead nettle, red	R	100 mm			100 mm	2 ETL	R	C	2 ETL	
Fat hen	R	100 mm	C		2 ETL	2 ETL	R	C		2 ETL
Field pansy	R		C		1 ETL		R	C		
Field penny cress	R	100 mm	C				R	C		
Forget-me-not, field	R	100 mm	C		4 ETL	2 ETL	R	C	2 ETL	
Groundsel	R	100 mm	C	6 ETL	1 ETL	2 ETL	R	C	2 ETL	
Henbit dead nettle	R	100 mm	C		100 mm	1 ETL	R	C		
Knotgrass	R		C		1 ETL		R	C		2 ETL
Mayweed	R	100 mm	C	6 ETL	2 ETL	50 mm	R	C	4 ETL	
Mercury, annual	R	100 mm					R			
Mustard	R	100 mm			6 ETL		R			
Orache, common	R	50 mm			1 ETL		R	C		
Pale persicaria	R	50 mm			2 ETL		R	C		
Parsley-piert	R	100 mm			1 ETL		R			
Pineapple weed	R	100 mm		6 ETL			R		4 ETL	
Plantain	R	100 mm					R			
Radish, wild	R	50 mm	C		100 mm		R	C		
Redshank	R	50 mm	C		100 mm	1 ETL	R	C		2 ETL
Scarlet pimpernel	R	100 mm	C		100 mm		R			
Shepherd's purse	R	50 mm	C		100 mm	4 ETL	R	C		2 ETL
Small nettle	R	100 mm	C		100 mm		R	C		2 ETL
Smooth sow thistle	R	100 mm	C	6 ETL			R			
Sorrel, sheep's	R						R			2 ETL
Speedwells	R	100 mm	C		100 mm	4 ETL	R	C	2 ETL	2 ETL
Spurrey, corn	R	50 mm					R	C		
Thale-cress	R						R			
Volunteer oil seed rape	R						R			
Wild carrot				2 ETL				C		
Willow-herb	R	50 mm					R			
Grass weeds										
Annual meadow grass	R	FT	C		FT		R	C	2 ETL	FT
Bents	3 ETL	FT					4 ETL			FT
Black grass	3 ETL	FT	C		2 ETL		FT		2 ETL	FT
Brome, barren	3 ETL				2 ETL		FT			FT
Common couch	3 ETL[a]	3 ETL					4 ETL			FT
Creeping bent	3 ETL[a]	3 ETL					4 ETL			FT
Onion couch	—	—					4 ETL			
Rye grass	3 ETL	3 ETL			3 ETL		FT			FT
Volunteer cereals	3 ETL	FT					FT			FT
Wild oats	3 ETL	FT	C				FT			FT

Key Growth stage of weeds (latest at which controlled):
C: cotyledon
ETL: number of expanded true leaves
mm: spread or height of weeds
FT: fully tillered
R: resistant

Notes [a] Refers to these weeds growing from seed. Perennial growth should be treated when plants are at 4 ETL stage to early shoot extension but before flowering (see text for rate).

Glyphosate, glufosinate-ammonium and paraquat control most weeds post-emergence. Glyphosate should be used to control rhizomatous weeds. These herbicides must not be allowed to come into contact with trees.

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