



Herbaceous perennials

A guide to the production of container grown plants

Andrew Hewson, ADAS



Contents

Introduction	1
Background	1
Market trends	1
Market segmentation	2
Versatility	2
Companion crops	4
Propagation	4
Seed	
Cuttings	
Root cuttings	5
Division	
Micro-propagation	6
Growing media and nutrition	6
Growing in larger pot sizes	7
Pest and disease control	8
Important pests of herbaceous perennials	
Important diseases of herbaceous perennials	10
Weed control	12
Crop scheduling	14
Growth control	14
Dealing with unsold crops	15
Further information	15
HDC reports	
HDC factsheets	16
HDC guide	
Defra guide	
Acknowledgements	16

Introduction

The market demand for high quality container grown herbaceous perennials continues to develop and there is still considerable scope for growers to increase market share. This guide considers the current market trends, the cultural requirements of herbaceous crops and the production methods employed.

Background

Herbaceous perennials are non-woody plants which usually grow and flower during the spring to autumn period, before dying down to a ground level crown or similar perennating organ such as a bulb or rhizome, to over-winter as a dormant plant.

Traditionally, the crop was field grown on a 1 or 2 year production cycle, using a bed system to facilitate mechanisation, before being lifted during the dormant period for sale or growing-on as a bare-root plant. For garden centre, pre-pack and mail order sales, the plants were usually root-wrapped in a polythene sleeve prior to dispatch.

Although some of this production continues, much of the lifted crop is now containerised for garden centre sales and year-round landscaping purposes. In fact during the last decade, the area of field production has significantly declined as plug plant technology and container-growing have advanced. Similarly, more herbaceous production is now carried out under protection (often, from plug plants) to improve quality, speed of growth and reduce crop wastage.

Market trends

The popularity of herbaceous perennials as versatile, easy to grow garden plants continues undiminished, and modern breeding programmes have developed new varieties offering colour and interest throughout most of the year. Container production and more imaginative marketing have revolutionised the market place. The potential for year-round planting of container grown stock is particularly attractive to landscapers, whilst the ability to sell plants in flower and looking good is considered crucial for retail sales.

In recent years, bedding plant producers have also begun to take a much closer interest in herbaceous crops and this has changed the dynamics of the market considerably, exploiting to good effect the commonality in cultural requirements and the complementary nature of the two crops. Such producers are increasingly well-mechanised and have spare capacity during the summer period, and so herbaceous perennials are seen as an attractive crop. Typically, such producers buy in most of their herbaceous requirements as seed raised plug plants, mostly first-year flowering species as little space is available for longer-term crops.

Some plug plant material is also purchased during the late autumn period for early spring sales (prior to summer bedding plant sales) or purchased in early spring for selling alongside bedding lines. These plants are produced in a range of packs and pot sizes.

Such growers are particularly well placed to develop the marketing opportunities that can be exploited by the intensive production techniques which were examined in the HDC projects PC 246, PC 247 and PC 267.



Commercial container production of herbaceous plants

Market segmentation

In recent years, the market for herbaceous perennials has segmented according to the needs of a range of different key customer groups, including:

- Amenity landscape
- Domestic landscape
- Garden centre
- Major retailer
- Niche or specialist market

This has led to distinct product differentiation according to the group being supplied.

Whilst the amenity market can be characterised by its increasingly year-round demand for large volumes of 'core varieties', landscapers servicing the domestic market (homeowners) require greater choice but more modest quantities. Increasingly, both require larger plants (typically, grown in 2 or 3 litre pots) for impact planting.

Garden centres usually prefer a traditional 'A to Z' range of the most popular garden varieties, in 1, 2 and 3 litre pots, although there is some demand for larger plants. Retail demand is highly seasonal, with around 75% of the product being required for spring sales, usually from late February onwards. Increasingly, retailers require a 'little and often' supply of, 'looking good' varieties.

The requirements of the major DIY retailers are quite similar to those of independent garden centres in terms of timing and range, although the traditional 9 cm pot remains important and there is a much sharper focus on scheduled production timed for specific week numbers, produced to a set retail price point. Good shelf-life qualities, clean pots, weed-free plants and attractive point-of-sale material are all essential prerequisites of the retail market.

There is also a rising demand amongst some retailers and 'high-end' domestic landscapers for what are considered 'niche' or specialist plants (for example, *Asarum europaeum*, a ground cover plant suitable for deep shade) and some native herbaceous perennial species more commonly associated with woodland floor landscapes.

Versatility

Herbaceous perennials (as a group) tolerate a range of soil types and adapt well to a range of garden or landscape situations, which broadens their appeal. They are also hugely versatile and associate well with a range of other garden plants, often for example providing the perfect foil in mixed borders. In addition to successional flowering and decorative foliage, many species also provide excellent ground cover and combine well with ferns, ornamental grasses, patio plants and flowering bulbs.



Herbaceous borders remain a popular feature of many parks, gardens and landscaped areas

Examples of popular herbaceous species suitable for different locations

Sun	Shade	Damp
<i>Acanthus</i>	<i>Aconitum</i>	<i>Aruncus</i>
<i>Artemisia</i>	<i>Alchemilla</i>	<i>Astilbe</i>
<i>Alchemilla</i>	<i>Astrantia</i>	<i>Caltha</i>
<i>Aster</i>	<i>Anemone x hybrida</i>	<i>Eupatorium</i>
<i>Centranthus</i>	<i>Bergenia</i>	<i>Filipendula</i> (some)
<i>Crambe</i>	<i>Brunnera</i>	<i>Hemerocallis</i>
<i>Crocsmia</i>	<i>Campanula</i> (some)	<i>Heuchera</i>
<i>Diascia</i>	<i>Dicentra</i>	<i>Hosta</i>
<i>Doronicum</i>	<i>Digitalis</i>	<i>Houttuynia</i>
<i>Echinacea</i>	<i>Epimedium</i>	<i>Iris pseudacorus</i>
<i>Echinops</i>	<i>Geranium</i> (some)	<i>Iris sibirica</i>
<i>Eryngium</i>	<i>Helleborus</i>	<i>Ligularia</i>
<i>Geranium</i> (some)	<i>Heuchera</i>	<i>Lythrum</i>
<i>Gypsophila</i>	<i>Hosta</i>	<i>Lysimachia</i>
<i>Helianthus</i>	<i>Lamium</i>	<i>Monarda</i>
<i>Helenium</i>	<i>Liriope</i>	<i>Primula</i>
<i>Iris</i> (bearded)	<i>Meconopsis</i>	<i>Rheum</i>
<i>Kniphofia</i>	<i>Polygonatum</i>	<i>Rodgersia</i>
<i>Rudbeckia</i>	<i>Primula</i>	<i>Symphytum</i>
<i>Salvia</i>	<i>Pulmonaria</i>	<i>Zantedeschia</i>
<i>Sedum</i>	<i>Rodgersia</i>	
<i>Sidalcea</i>	<i>Symphytum</i>	
<i>Solidago</i>	<i>Tricyrtis</i>	
<i>Verbascum</i>	<i>Trollius</i>	

Some of the more versatile herbaceous perennials for example *Alchemilla*, *Heuchera* and varieties of hardy *Geranium* often grow happily in either sun or shade or wet or dry situations.

Companion crops

Increasingly, a range of alpines, spring flowering bulbs, herbs, ornamental grasses, hardy ferns and various sub-shrubs are also commercially produced alongside herbaceous perennials as companion crops. These are grown primarily to extend the season of interest and develop sales opportunities beyond the traditional spring/summer sales period, as well as being in strong demand for landscaping schemes of all types. Such crops share similar cultural needs and complement herbaceous perennials well in terms of their commercial production requirements.

Propagation

A range of methods are used to propagate herbaceous crops, including seed; basal, soft, semi-ripe or root cuttings and division. Whilst some growers still propagate from their own stock, most now buy in all or a proportion of their requirements from specialist suppliers as plug plants, liners or bare-root plant material for growing-on. Buying-in liners or established plug plants for growing-on is likely to be a more convenient route for new entrants to the industry, particularly those with less experience of plant propagation.

Seed

Many herbaceous subjects are now raised by seed to produce plug plants for growing-on during the spring and summer months in larger pot sizes, usually 9 cm or 1 litre pots. Whilst some nurseries raise a proportion of this crop themselves, usually via direct sowing into plug trays or 9 cm pots (for example *Lupinus*), a significant volume is also produced by well-mechanised and highly automated specialist young plant suppliers. Popular seed raised crops include varieties of *Achillea*, *Alchemilla*, *Aquilegia*, *Aster*, *Bergenia*, *Campanula*, *Digitalis*, *Dicentra*, *Delphinium*, *Doronicum*, *Echinacea*, *Geum*, *Helenium*, *Lupinus*, *Lychnis*, *Papaver*, *Sidalcea* and *Solidago*. However, not all varieties 'come true' from seed and so require vegetative propagation, typically from stem or basal cuttings.

Cuttings

A wide range of herbaceous perennials including *Delphinium*, *Helichrysum*, *Lamium*, *Nepeta*, *Penstemon* and *Salvia* can be readily propagated from soft or semi-ripe cuttings taken during the spring/summer period. Usually, these are direct-stuck into plug trays of varying sizes for ease and speed of handling, and rooted under polythene and/or mist. Base heat is not usually required in summer but will accelerate rooting. With most herbaceous subjects, rooting occurs quickly (often within 2 weeks) and with high percentage success rates, after which material is weaned prior to potting on. Adequate shading is important during the summer, particularly in the absence of mist propagation. Hormone rooting treatments are usually unnecessary, but diseases such as *Botrytis* and

Pythium can pose problems and require control. Many herbaceous perennials can also be propagated successfully from basal cuttings, whereby cuttings are taken from shoots which arise from the base of the plant, for example in the case of clump-forming perennials such as *Achillea*, *Delphinium*, *Phlox* and herbaceous *Clematis*. Such material often has a higher propensity for rooting, and so is particularly useful for the propagation of those subjects which are less inclined to root from softer stem cuttings, for example *Astrantia* 'Suningdale Variegated', *Campanula lactiflora*, *Campanula latiloba* and *Salvia nemerosa*. It is also a useful technique for rooting *Aster*, when basal cuttings are best removed, before plants enter their floral state and extend in height. Basal cuttings do sometimes come away with roots attached, and in such cases are more akin to 'mini-divisions' than true cuttings.



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Ferns and ornamental grasses associate well with herbaceous perennials and are often grown as companion plants to extend the season of interest

Root cuttings

This is a traditional and low-cost way of propagating a surprisingly wide range of popular herbaceous perennials, including varieties of *Acanthus*, *Anchusa*, *Crambe*, *Echinops*, *Eryngium*, *Phlox paniculata* and *Verbascum*. Cuttings are usually prepared during the late autumn, winter and early spring months from field or container grown stock plants and inserted into plug trays or 9 cm pots filled with a propagation medium or a growing medium suitable for liners. They are then placed in a dry, frost free location under glass or polythene to develop (base heat, whilst not essential, will accelerate root development and help minimise losses). Callusing, root and shoot formation then occurs during the winter/spring period, after which the young plants are lined out in nursery rows or potted-up for growing-on and sale, usually from late summer onwards; depending upon species, market requirement and pot size. Plants required for sale in larger pot sizes need to be propagated earlier in the production cycle.



Acanthus responds well to propagation from root cuttings during late February and early March



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Division

Division is a reliable, quick and economic method of increasing stock, mostly undertaken during the autumn/winter period (although *Iris* and *Hemerocallis* respond well to summer propagation). Divided bare-root material is then lined out or containerised for growing-on the following summer. Whilst relatively straightforward, this method does require significant quantities of well managed stock plants to ensure adequate propagation material is available, and provide continuity of supply. (The HDC factsheet 14/04 provides further guidance on the establishment and management of stock plants for propagation). Usually, the older, central portion of the crown of the plant is discarded and the younger, more productive outer portions used for propagation. Perennials frequently propagated by division include *Aster*, *Astilbe*, *Doronicum*, *Geranium*, *Hemerocallis*, *Rodgersia* and *Rudbeckia*. It is still possible to buy open-ground stock for growing-on or re-sale from a number of suppliers.



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Division remains a popular and reliable method of propagation for herbaceous crops such as *Iris*

Micro-propagation

An increasingly wide range of herbaceous subjects are grown from young plants raised by micro-propagation. Such material, with its potential for enhanced uniformity and vigour is usually bought-in from specialist nurseries as weaned plants in plug trays ready for potting-on. The process is often used for the rapid bulking up of new varieties. Currently, *Heuchera* and *Hosta* are of particular interest, whilst varieties of *Crocasmia*, *Echinacea*, *Kniphofia* and *Papaver* are also raised in this way. However, such material requires careful handling on the nursery to ensure successful establishment. Bought-in stock should preferably be fully weaned before delivery.

Occasionally, very young plant material may arrive on the nursery which requires particularly careful weaning prior to potting-on. In such cases, high humidity 'supportive' environments such as those provided by mist or fog are required to ensure the material does not deteriorate. Such environments need to be well controlled as it is especially important not to over-wet the plants.

Growing media and nutrition

Herbaceous perennials require an open, well-drained growing medium to enable rapid root development and growth, particularly longer term crops which are over-wintered in outdoor situations. Mixes based on 75:25 sphagnum peat with composted pine bark work well, although commercial experience to date with a range of herbaceous varieties also shows that they respond well to peat-free or reduced-peat mixes based on bark,

wood-fibre or coir (due largely, to the more open nature of such substrates). A small percentage of loam is still used in some mixes, which provides a useful degree of nutrient buffering and helps reduce drying out and there is some interest in green compost. However, the latter material can add considerable weight to a mix, which may have handling and transport implications. It may also have a high pH and quite elevated salt levels hence it is usually used at no more than 10% of the total mix volume.

Growing media mixes with a high percentage of non-peat material (higher than 40%) require greater adaptation in terms of irrigation and nutrition management. They tend to dry out more quickly on the surface, even when the medium is adequately moist underneath, and so there is a greater risk of over-watering. However, they are usually easier to re-wet than traditional peat mixes and the drier surface helps to discourage weeds, particularly liverwort. Mixes containing forestry by-products like bark and wood fibre usually require supplementary nutrition to counteract nitrogen immobilisation. It is always advisable to trial and monitor new mixes on a small scale first before using them more widely on the nursery. Further information on nursery scale trials can be found in the HDC factsheet 01/08.

As far as nutritional requirements are concerned, although many herbaceous subjects may be deemed 'gross feeders' in garden situations and so necessitate generous fertiliser rates, there is a tendency for them to grow too soft and too quickly in containers, particularly if potted early in the season. This frequently makes them difficult to manage and keep saleable. They may also be more susceptible to pest and disease problems, and in the case of longer-term crops, winter injury. To help counteract this, single season controlled release fertilisers

with less nitrogen and additional potash can be used. Rates vary, but are typically 3.0–3.5 kgs of fertiliser per m³ of growing medium. Higher rates (for example, over 4 kgs/m³) of longer term formulations should be considered for specimen grade plants and over-wintered crops. For very short-term spring or summer potted crops, a 3–4 month or 5–6 month product should be used (1.5–3.5 kg/m³).

For propagation using plug trays and particularly where the cell size is less than 5 cm, mini-granules are usually recommended (0.5–1.5 kgs/m³).

Herbaceous growing media mixes usually require a balanced base fertiliser (for example 14:16:18 NPK) for immediate nutrient provision and to counteract nitrogen immobilisation where bark or similar materials are used.

In terms of pH requirements, a starting pH of 5.5–6.0 usually suffices for most herbaceous subjects, although this may need to be reduced slightly in hard water areas where the bicarbonate level of the irrigation water is high (above 200 mg/l). The HDC factsheet 05/05 provides more detailed guidance on the nutrition of container grown plants.

Growing in larger pot sizes

In recent years, a significant demand has developed amongst landscapers and retailers for larger, specimen grade plants in order to provide immediate impact and complement sales of the traditional 9 cm and 1 litre pot product. In response to this trend, the production of herbaceous crops in 2, 3 and 5 litre pots has increased, although this brings with it considerable production and cost implications, particularly in terms of bed space, irrigation, nutrition, shelf-life requirements, materials handling and, not least, transport.

Whilst some herbaceous perennials look particularly attractive in larger pots (for example, varieties of *Astilbe*, *Dicentra*, *Hosta*, *Iris*, *Hemerocallis*, *Lupinus* and *Delphinium*), some subjects are less well suited. It is important therefore to choose the right crops for this system of production. A more open growing medium will be necessary, particularly for those crops over-wintered outside, as whilst most herbaceous perennials are very hardy, prolonged spells of wetness can lead to root damage. In terms of shelf-life, larger pots frequently remain in retail plant areas for considerably longer than their 9 cm counterparts and this also needs to be considered when taking account of nutritional requirements.

Whilst most crops can be overwintered 'pot-thick' for added root protection and to economise on bed space, a greater production area will still be required as plants will need spacing during the summer.

As a guide, in terms of starting material and potting, plants destined for 2 and 3 litre pots may require a large plug plant or 9 cm 'liner' to make saleable plants quickly, whilst perennials grown in larger pots, for example 5 litres respond quickly to potting-on from a 1 or 2 litre pot, depending on the vigour of the variety, timeframe and final pot size. Crops grown and marketed in 1.5 or 2 litre pots are also often produced by potting 2 or 3 plug plants per pot, for example in the case of varieties of *Aquilegia*, *Doronicum*, *Geranium*, *Delphinium* and *Lupinus*. Such



A range of herbaceous perennials, for example *Crocasmia* can be successfully raised by micropropagation



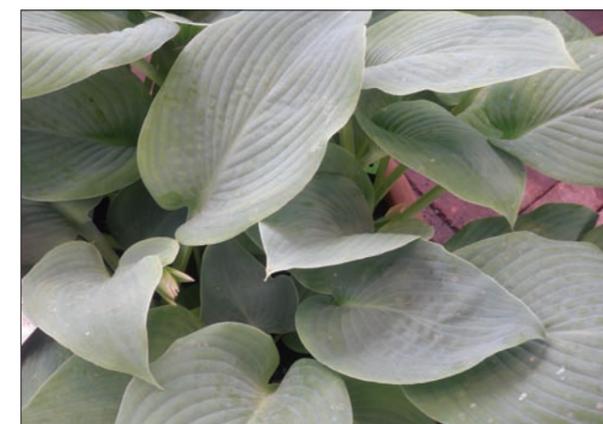
Many herbaceous perennials can be grown successfully in reduced-peat and peat-free growing media, with their potential for rapid root development and growth



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Herbaceous perennials such as *Astilbe*, *Dicentra*, *Hosta* and *Rudbeckia* lend themselves well to specimen production, for which there is an increasing market demand

crops are usually established under protection before being grown-on outside in order to contain growth, or under open-sided tunnels to provide winter protection.

Whilst it is difficult to be too prescriptive about production timeframes for these crops, it is fair to say that these have shortened considerably, in line with modern market requirements and the steady shift towards more protected cropping. During the spring and summer for example, it is not unusual for some 2 litre herbaceous crops destined for major retailers to be grown and sold within weeks when potted-on from good quality plug plants, particularly when grown under protection. Conversely, in traditional nursery stock situations, a considerable volume of stock is still produced for spring and summer sales from over-wintered crops potted the previous year, or from winter potted bare-root divisions. Typically, much of this production is absorbed by the amenity landscape sector and independent garden centres.

Pest and disease control

Some herbaceous perennials are prone to pest and disease problems, mainly when in active growth during the spring/summer period. Under protection, biological pest control as part of a integrated pest management (IPM) programme can be considered, but in outdoor situations a routine spray programme may be required. Pests of particular note include aphids, two-spotted spider mite, caterpillar, leaf and bud nematode, slugs, snails and vine weevil. Sciarid fly larvae can also be a frequently

damaging pest of herbaceous crops such as *Aubretia* and *Primula*, particularly during propagation and amongst plug plant crops. Similarly, the effective control of diseases such as *Botrytis*, powdery mildew, downy mildew, rust and lupin anthracnose often require a regular fungicide programme. Powdery mildew is a particular threat to many herbaceous crops throughout the spring/summer period as it is a debilitating, highly visual disease which spreads quickly. It also has a broad and significant host range, including *Aster*, *Geranium*, *Penstemon*, *Phlox* and *Scabiosa*. Lupin anthracnose has in recent years also emerged as a serious problem on *Lupinus* and one requiring vigilance, disciplined crop monitoring and good husbandry, alongside a routine fungicide spray programme.

Good hygiene, clean stock and routine crop monitoring are fundamental in reducing background pest levels and disease pressure, particularly in respect of *Botrytis* and vine weevil, both of which are difficult to control solely with pesticides. Careful water management and avoiding overly wet crop environments will also help to discourage slugs and snails, which can wreak havoc amongst herbaceous crops such as *Hosta* and *Ligularia*.

Important pests of herbaceous perennials

Leaf and bud nematode

A serious pest of herbaceous crops, most notably of *Anemone x hybrida* cultivars, where the dark, angular leaf markings created by this pernicious pest can quickly render crops unsaleable. Similarly *Geum* and *Penstemon* are frequent hosts for this pest, whilst *Aster*, *Delphinium*,



Typical leaf damage caused by the leaf and bud nematode on *Anemone*

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Doronicum, *Heuchera*, *Lamium* and *Paeonia* have also been recorded as host crops. Chemical control is difficult, largely due to the habit of this pest, and its ability to spread rapidly between plants through surface leaf moisture. Insecticide use may also be complicated by crop safety concerns. Cultural control measures are therefore vitally important in the successful control of this pest, most notably good nursery hygiene, low-level irrigation and the use of clean stock.

The HDC projects HNS 60 and HNS 131 reviewed the biology and control of this pest, whilst the HDC factsheet 'Bud and leaf nematodes' provides further information about the host range, biology, symptoms, survival, spread and cultural control of this pest.

Slugs and snails

Slugs and snails are frequently occurring and highly damaging pests of herbaceous crops, especially those with large leaves such as *Hosta* and *Ligularia*. The damage is usually very visible and can occur quickly when pest populations become established. Over-wintered crops can be particularly vulnerable, as the pests frequently attack the first flush of spring growth and the crowns of plants, which then fail to grow away well.

Although a range of pelleted products for the control of slugs and snails are currently on the market, they are seldom fully effective and those based on methiocarb or metaldehyde can pose an environmental risk and so must be used with particular care. However, recently introduced products based on ferric phosphate (Ferramol and Sluggo) are generally considered safe to wildlife and beneficial insects such as ground beetles, although as with other pelleted products, they need to be applied promptly, regularly and when crop damage is first spotted.

Careful water management, good bed drainage and rigorous nursery hygiene will help to reduce pest numbers. Loose-fill pot mulches of bark or grit which are sometimes used for weed control also discourage slugs and snails by keeping the surface of the growing media drier. The HDC project HNS 105 highlighted the potential of permeable ground cover fabrics impregnated with copper hydroxide for discouraging slugs and snails. Biological control using the mollusc pathogenic nematode *Phasmoditis hermaphrodita* (Nemaslug) can also provide a useful degree of control during the spring and autumn months. HDC factsheet 07/02 provides an overview of the integrated control measures for slugs and snails.

Vine weevil

One of the most damaging and difficult to control pests of herbaceous perennials; the principal host plants of this pest include varieties of *Heuchera*, *Primula* and *Sedum*. The adults cause an unsightly marginal leaf notching of summer foliage whilst the larvae attack the root systems, usually during the autumn/winter period leading to a rapid collapse of spring growth. Whilst growing media incorporated insecticides are widely used to control vine weevil larvae, disciplined nursery hygiene and clean stock are important cultural control measures.



Ligularia is one of several herbaceous crops frequently attacked by slugs, which require prompt control

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Vine weevil (adults and larvae) remains a particularly damaging and difficult to control pest of herbaceous crops

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Biological control using products containing insect pathogenic nematodes also provide effective curative control, providing their application is well targeted and correctly timed in order to control young larvae before damage occurs.

Research work has also highlighted the potential of the entomogenous fungus *Metarhizium anisopliae* for the biological control of vine weevil larvae in growing media across a range of container grown nursery stock, including herbaceous perennials, particularly when used alongside cold tolerant entomopathogenic nematode products (*Metarhizium anisopliae* being slow-acting at low temperatures).

Growing media incorporated insecticides such as Imidasect 5 GR (imidacloprid) and Exemptor (thiacloprid) can also be considered for the control of vine weevil larvae. The active ingredient imidacloprid is also available as Intercept 70WG for application as a growing media drench treatment. Suscon Green (chlorpyrifos), the growing media incorporated insecticide product which has become a standard vine weevil treatment for many nursery stock growers, will be replaced by a new formulation in 2011.

Further guidance on vine weevil control can be found in the HDC factsheet 02/03 and, in respect of *Metarhizium anisopliae*, the HDC report for project HNS 133.

The Defra publication *Integrated Pest Management In Protected Ornamental Crops – A Best Practice Guide for UK Growers*, provides further information in respect of pest control.

Important diseases of herbaceous perennials

Lupin anthracnose

This seed-borne fungal disease can be a frequent problem of lupins, where the now familiar leaf necrosis, wilting, shoot tip twisting and collapse can quickly render crops unsaleable. Gaining successful control with fungicides alone is often difficult, particularly where overhead irrigation is used as the disease is favoured by constant leaf wetness and spreads rapidly by water-splash. Irrigation during the early morning allows the crop foliage to dry off through the day and so helps reduce disease pressure. Whilst the use of fungicide or heat treated seed to protect against the disease is advisable, a routine fungicide spray programme will also be necessary in order to control secondary infections. Fungicide products which can currently be considered include Repulse¹ (chlorothalonil), Scotts Octave (prochloraz), Signum² (boscalid + pyraclostrobin) and Switch (cyprodinil + fludioxonil). Cultural control measures such as good levels of nursery hygiene, pot spacing, growing plants outdoors rather than under protection and, most crucially, the use of low-level rather than overhead irrigation will help to reduce disease pressure. As disease infection can persist over winter in and around dormant crowns and amongst decaying leaf debris, a thorough end of season clean-up is also advisable.



Lupin anthracnose remains a common problem of container grown crops, requiring cultural and chemical control

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Botrytis

A common problem, particularly during the autumn/winter period with crops grown under protection and for which cultural control measures such as fan ventilation, pot spacing, nursery hygiene and careful water management are especially important. Spray programmes including products such as Amistar² (azoxystrobin), Repulse¹ (chlorothalonil), Cercobin WG² (thiophanate-methyl), Scotts Octave (prochloraz), Rovral WG (iprodione) and Switch (cyprodinil + fludioxonil), which are drawn from different fungicide groups and so help mitigate disease resistance, will also be necessary to control outbreaks of the problem.

The HDC factsheets 23/02 and 24/02 provide useful background on the control of the disease in unheated and heated glasshouses.

Downy mildew

This disease attacks a fairly limited host range but can be devastating if allowed to progress unchecked; the typically dark, angular leaf markings being highly visible and very unsightly. Principal hosts include *Digitalis*, *Gaillardia*, *Geranium*, *Geum*, *Penstemon* and *Potentilla*. Poor air movement, sustained spells of leaf wetness and high humidity in and around plants favour the disease, and so cultural control measures such as low-level watering, pot spacing, venting of protected crops and good nursery hygiene all help to control the problem, particularly when linked to a regular fungicide spray programme. Currently approved products which can be considered include: Aliette 80 WG (fosetyl-aluminium), Repulse¹ (chlorothalonil), Fubol Gold WG² (mancozeb + metalaxyl-M) and Signum² (boscalid + pyraclostrobin).



Digitalis is a common host of downy mildew, a disease which quickly renders crops unsaleable

© ADAS

Further information and guidance on the control of this disease can be found in the HDC factsheet 04/04.

Powdery mildew

A common disease problem of herbaceous perennials, attacking a wide host range including *Aster*, *Ajuga*, *Aquilegia*, *Doronicum*, *Euphorbia*, *Geranium*, *Monarda*, *Scabious* and *Solidago*. Although the disease is usually most active and visible during the warmer, drier summer months, a regular fungicide programme which begins promptly during the spring and continues well into the autumn is often necessary for effective control, particularly of primary infections which appear early in the year, where the disease has overwintered in dormant buds/crowns. Suitable fungicides which can be considered include: Amistar² (azoxystrobin), Nimrod (bupirimate) and Systhane 20 EW (myclobutanil). Low-level watering and clean stock are equally important cultural control measures.

Phytophthora

Herbaceous perennials are also susceptible to a range of soil and water borne disease infections, most notably *Phytophthora* and the HDC factsheet 16/04 provides further information on the symptoms and control of this disease.

(¹ Products containing only chlorothalonil will be revoked at the end of August 2011).

(² Denotes products which are approved for use on ornamental crops via a Specific Off-Label Approval (SOLA). The use of products via a SOLA is entirely at the risk of the user).

Weed control

Annual weeds such as bittercress and groundsel can be a recurring problem with container grown crops, however the wide range of herbaceous species grown, some of which are particularly sensitive to herbicides, complicates the safe use of such products. Currently, there are no herbicide products with specific label recommendations for use on container-grown herbaceous perennials and so it is particularly important to maintain high standards of nursery hygiene and use clean stock in order to reduce background weed pressure. Typically, good nursery hygiene involves:

- Ensuring bought-in plants are clean and weed free (including plugs, liners and bare-root divisions)
- Keeping growing media/bulk ingredients clean and covered when stored
- Covering irrigation tanks to prevent weed seed contamination
- Ensuring non-crop areas are kept clean and weed free (for example headlands, boundaries, areas between beds and tunnels etc)
- Cleaning and disinfecting growing areas and benches thoroughly before setting crops down
- Using clean pots and trays at potting

- Keeping old stock away from newly potted material
- Prompt removal of waste from the nursery

The HDC factsheets 10/07 and 15/05 provide further guidance on nursery hygiene measures and disinfectant selection, whilst the HDC factsheet 06/08 provides information on handling bought-in plant material.

Quick growing single season herbaceous crops can often be produced without the need for herbicides, providing there are good levels of nursery hygiene and that young plant material is weed free. There is some interest in the use of loose-fill pot mulches such as bark, coir or grit to control weeds, and such materials are particularly useful for the control of moss and liverwort. Similarly, pot toppers (a permeable cover seated around the base of the plant covering the growing media to prevent weed seed germination) can be considered, although these are less suitable for multi-branched or suckering herbaceous perennials. Whilst the use of such materials may present some difficulties, not least in terms of efficient application, they can be useful for weed control in herbicide sensitive crops and in situations where the use of chemicals may be difficult or inappropriate.

So far as chemical weed control is concerned, residual herbicides such as Ronstar 2G (oxadiazon) and Flexidor 125 (isoxaben) are currently used on container grown herbaceous crops. Ronstar 2G can be used under protection, providing conditions are cool and the structure well vented, whilst Flexidor 125 currently has a SOLA for indoor use.



Pot mulches are an environmentally friendly and safer alternative to herbicides

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An alternating programme combining both products usually controls the main annual weeds of concern, most notably bittercress, chickweed, groundsel and willowherb. Some herbaceous subjects though can be sensitive to oxadiazon in terms of growth suppression (for example *Aruncus*, *Delphinium*, *Digitalis* and *Sedum*) and isoxaben (for example *Anemone*, *Aruncus*, *Diascia*, *Digitalis*, *Eryngium*, *Penstemon* and *Phlox*), and they are particularly susceptible when in active growth. Crucifers such as *Aubretia*, *Alyssum*, *Crambe* and *Erysimum* can also be sensitive to isoxaben, as can *Veronica* and *Veronicastrum*. However, whilst herbicides may cause some suppression of growth, the plants usually recover and this may be an acceptable compromise when compared to the cost of hand weeding.

Ronstar 2G can be considered as a post-potting treatment, but should not be used on plants with cupped foliage which may trap the granules or on varieties with an overtly suckering habit, as damage may occur. It is usually considered safe for autumn/winter application when herbaceous crops are at their most dormant. Accurate granule application is also easier when the crops have died down, leaving a more exposed growing media surface.

With established crops, Flexidor 125 can be considered throughout the year, although there is sometimes a preference to hand weed during the mid-summer period when growth is particularly soft and more liable to damage. During this period, dense crop canopies tend to provide a natural degree of weed suppression, reducing the need for herbicides and their potential risks.

Venzar Flowable (lenacil) used under the Long Term Arrangements for Extension of Use (LTAEU) can provide good weed control in container grown crops, particularly of bittercress and liverwort. However, it may cause some crop damage, especially if used during periods of active growth. For this reason, autumn/winter applications are advisable. Several herbaceous species are particularly sensitive to lenacil including, *Delphinium*, *Digitalis* and *Euphorbia*.

Some use is also made of Devrinol (napropamide) on herbaceous crops in outdoor situations during the autumn/winter months when it is more effective, and usually quite safe. It provides good residual control of groundsel and meadow-grass and so is a useful complement to Flexidor 125.

The safe and effective control of moss and liverwort is arguably more challenging as they are easily spread, can quickly establish and are resistant to many herbicide products, including Flexidor 125 (and to a lesser degree, Ronstar 2G). Whilst winter applications of Venzar Flowable will provide some control and the HDC project HNS 166 is assessing further herbicide options more widely, cultural control measures, particularly disciplined water application are especially important in order to control these problems. Routine applications of fungicides containing chlorothalonil' and thiram also provide a useful degree of control.

The HDC Weed Control Handbook is an important source of reference, particularly in terms of the herbicide tolerance of herbaceous subjects.



Liverwort is a common problem of container grown crops, for which cultural control is particularly important

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Crop scheduling

Scheduling the flowering of herbaceous perennials enables their season of interest to be extended beyond the traditional sales periods. Research has considered how the flowering of some herbaceous subjects can be controlled to commercial advantage by manipulating the growing environment, mainly through the use of different chilling and then subsequent lighting and heating regimes to advance or 'force' plants into flower for early season sales.

The HDC project PC 246 for example confirmed that intensive forcing programmes developed in Germany can be replicated under UK conditions to produce a range of seed raised, early flowering perennials in 10 cm pots during February and early March. However, such techniques require high energy inputs and so may only be attractive to protected crop producers with access to good quality glasshouses and supplementary lighting facilities. More detailed guidance can be found in the final project report.

Other HDC funded projects, most notably HNS 103 and 103a have also examined different aspects of crop scheduling, which may be of particular interest to hardy plant producers. Night-break lighting for example has been shown to promote and increase flowering in a range of 'long-day' herbaceous subjects, including *Anemone x hybrida* 'Whirlwind', *Aster* 'Marie Ballard', *Crocsmia* 'Star of the East', *Penstemon* 'Mother of Pearl' and *Rudbeckia fulgida* var. *sullivantii* 'Goldsturm'. However, whilst this technique may enhance new sales

opportunities, for example during early spring, it also requires careful management in order to avoid plants stretching, particularly if lighting is combined with heating (to increase the rate of flower development following initiation). In the case of *Anemone x hybrida* 'Whirlwind', flower numbers were increased further when the plants were initially subjected to a period of cold storage whilst with *Rudbeckia fulgida*, a short period of cold storage alone was enough to promote flowering.

Growth control

Growing herbaceous crops (or, moving them) outside for the summer period is one of the most simple methods to help control excessive growth. Sequential sowing or potting-on of small batches of plants are also useful cultural methods for controlling plant growth, as is the selection of varieties with a compact or less vigorous habit. Potting vigorous crops later in the season is also an effective means for controlling growth. Controlled temperature storage, although primarily a scheduling aid, can be a useful growth control tool, for example with young plants raised in plug trays.

Plastic cladding materials incorporating spectral filters which alter the wavelength of light passing through them have been shown, as part of the HDC project HNS 108, to control growth across a range of nursery stock subjects, including some herbaceous perennials. However, some form of initial nursery trialling is advisable as species vary in their sensitivity.



Chemical growth control (right) of *Salvia* to control plant habit

In terms of chemical growth control, there are currently three main active ingredients used for growth regulation on ornamental crops in the UK: chlormequat, daminozide and paclobutrazol. Primarily, they control plant height by reducing the stem internode length, although they also promote branching and have an effect on plant habit, foliage colour and, in some crops, flowering. For optimum results, it is important that they are applied at a particular physiological stage in the development of the plant and not scheduled by time. The number of leaves is sometimes used as a visual indicator for the initial application and a programme of treatments is usually required thereafter. Whilst there is a role for chemical growth regulators in controlling the rapid spring/summer growth of particularly vigorous herbaceous crops (as demonstrated in the HDC project HNS 103b), they should not be considered a substitute for good crop husbandry.

Dealing with unsold crops

Managing unsold stock is a common problem and whilst such plants can sometimes be potted-on for future sales, they can also become a frequent source of pests, diseases and weeds. They can also occupy valuable bed space unproductively for long periods of time and require frequent cutting back beyond the usual 'one-off' pruning in summer, in order to remain saleable, particularly when grown under protection. Fertiliser top-dressing or liquid feeding may also be required, unless the plants are to be potted-on.

Each of these tasks involves extra costs, and so it is important to forward plan crop production carefully in order to at least mitigate the problem. For example, only grow or



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Herbaceous crop cut back to induce fresh growth

buy-in what is required and try to batch-pot crops to create a succession of looking-good plants over the spring and summer months.

During early summer, unsold crops can be cut back to promote fresh growth, taking the opportunity to top-dress and hand weed where required. This can be done in batches to provide flushes of rejuvenated stock for sale. Avoid mixing these plants in with new or freshly potted crops in order to simplify cultural work, particularly irrigation and crop protection.

Further information

HDC reports

PC 267: Collaborative research programme in partnership with Saxon State Institute for Agriculture, Pillnitz, Germany for the development of 'new' ornamental plants for early season sales. Part II: Scheduled production and quality improvement.

PC 247: Collaborative research programme in partnership with Saxon State Institute for Agriculture, Pillnitz, Germany for the development of 'new' ornamental plants for early season sales.

PC 246: Garden Plants: Development of new marketing opportunities based on controlled flowering of herbaceous perennials for early spring and late summer sales.

HNS 166: Hardy Ornamentals: Herbicide screening for herbaceous perennials and grasses.

HNS 133: Development of the entomogenous fungus *Metarhizium anisopliae* for the control of vine weevil and thrips in horticultural growing media.

HNS 131: Hardy Nursery Stock: Evaluation of alternatives to aldicarb (Temik 10G) for the control and management of leaf bud nematodes.

HNS 108: Growth of a range of nursery stock subjects under different coloured and spectral filter plastic screens.

HNS 105: Hardy Nursery Stock: Integrated control of snails and slugs.

HNS 103b: Hardy Herbaceous Perennials: Workshop to explore the potential for crop scheduling and the effects of chemical plant growth regulators to optimise growth and habit.

HNS 103a Hardy Herbaceous Perennials: Value of a screening protocol for factors that manipulate flowering.

HNS 103: Hardy Herbaceous Perennials: A review of techniques for manipulating growth and flowering.

HNS 60: Hardy Ornamental Nursery Stock: A review of the biology and control of leaf and bud nematodes.

HDC factsheets

06/08: A guide to best practice in handling bought-in plants.

01/08: A guide to simple and effective nursery trials.

10/07: Guidelines on nursery hygiene for outdoor and protected ornamental crops.

15/05: Use of chemical disinfectants in protected ornamental production.

08/05: The biology and control of two-spotted spider mite in nursery stock.

05/05: Nutrition of container-grown hardy nursery stock.

16/04: Control of *Phytophthora*, *Pythium* and *Rhizoctonia* in container-grown hardy ornamentals.

14/04: Hardy Nursery Stock – Management of stock plants.

04/04: Control of downy mildew diseases on hardy nursery stock and herbaceous perennials.

02/03: Vine weevil control in hardy nursery stock.

24/02: Control of grey mould (*Botrytis*) in container-grown ornamentals: heated glasshouse crops.

23/02: Control of grey mould (*Botrytis*) in container-grown ornamentals: unheated greenhouse crops.

07/02: Integrated control of snails and slugs.

March 1997: Bud and leaf nematodes.

HDC guide

Practical weed control for nursery stock: An HDC growers' handbook.

Defra guide

Integrated pest management in protected ornamental crops – A best practice guide.

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**Horticultural
Development
Company**

Stoneleigh Park
Kenilworth
Warwickshire CV8 2TL
T: 0247 669 2051
E: hdc@hdc.org.uk

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