

# Winter protection of container grown nursery stock

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The protection of container grown nursery stock during the winter months is an essential component of quality production systems. Although recent winters have been relatively mild, a substantial quantity of container stock is frequently lost or downgraded due to winter injury. Such losses are often linked to waterlogged containers, a lack of effective winter protection and, most notably, inadequate conditioning of plants prior to the winter period.

This factsheet considers the principal causes of winter damage and details practical measures that growers can take to reduce losses.

## Background

It is difficult to accurately quantify the value of the national container crop that can be lost during a hard winter but it can be very significant indeed; at current industry levels, container plant

losses amounting to 5% for example would equate to an equivalent farm gate value approaching £15 m. During the winter of 2003/04, considerable damage was done to a range of container stock by frosts of up to 8°C. In an increasingly global and

competitive market, the need to reduce such losses is paramount. Providing effective winter protection need not be costly; planning ahead and implementing good nursery practice can significantly reduce over-wintering losses.



1 Protection of container grown nursery stock during the winter months is an essential component of quality production systems



2 Stem splitting/stem damage on conifer – upright conifer varieties are particularly prone to this kind of winter injury caused by wind frosts and desiccation

## Symptoms of winter injury

The symptoms of winter injury in container stock show themselves in different ways. Some of these symptoms are more immediate, such as the physical damage to stems and

branches caused by snow or ice. However, other symptoms can take longer to appear and not become apparent until the spring when new top growth may fail to develop, for example due to waterlogged root systems. The true impact on saleability can therefore be delayed and so difficult to assess until well

after the damage originally occurred. Key symptoms of winter injury are:

- Physical damage to stems or branches caused by strong winds, snow or ice
- Dead/decaying/discoloured roots due to water-logging and/or freezing temperatures

- Bark or stem splitting above ground/ just above growing media
- *Botrytis* infection typically following frost injury or physical damage
- Stem/crown die-back due to dead roots, frost damage and disease infection
- Failure of new growth to develop in spring and/or sudden collapse of new growth due to damaged root systems.
- Pronounced leaf-drop due to frost injury or waterlogged roots
- Discoloured leaves, usually brown, necrotic and 'scorched', often around the margins (eg evergreen subjects)
- Brown, dry discoloured foliage and needle drop with conifer varieties



3 Stem die-back is a common symptom of winter injury caused by damaged root systems, frost and subsequent disease infection

## Causes of winter injury

### Waterlogging

This is the most common type of damage and occurs even during mild winters. It is usually associated with poorly structured growing media and inadequate drainage of container beds. The availability of oxygen to the roots diminishes where an excess of free water occurs, leading in some situations, to extensive root death. Disease infection may follow as wet conditions encourage the development of soil/water borne pathogens such as *Pythium* and *Phytophthora*, the latter of which can be especially damaging even to established container stock. (See HDC factsheet

14/04 for further information on control of *Pythium* and *Phytophthora*).

Not only are waterlogged container plants less able to survive cold winter periods but they are also slower to resume growth the following season. Where extensive root loss has occurred, plants are often unable to recover and fail to grow in spring, leading to high levels of wastage.

Nursery stock subjects particularly susceptible to water logging include *Caryopteris*, *Cistus*, *Choisya*, *Convolvulus cneorum*, *Hebe*, *Ilex*, *Olearia*, *Rosmarinus* and *Senecio*. Many conifers are also susceptible, particularly cultivars of *Chamaecyparis lawsoniana*, *Juniperus* and *Taxus*.

Sustained spells of low temperatures coupled with waterlogged roots are a particularly damaging combination and likely to cause serious losses.

### Freezing injury

Freezing injury to leaves and stems occurs when ice crystals form within the cells of the plant causing the cells to rupture. Root systems can be similarly damaged; being situated above the ground in containers, they are exposed to much lower air temperatures than when grown in the open ground, where root systems are typically more extensive and robust. Injury to root systems is usually more serious and long term.

Waterlogged containers and standing beds damage root systems and exacerbate freezing injury, so predisposing plants to further damage. Nursery stock subjects such as *Cistus*, *Hebe*, *Lavendula* and *Senecio* are particularly vulnerable and frequently require protection from freezing temperatures.



4 Waterlogging damages root systems and is the most common cause of winter injury – growing media and container beds must be well drained and irrigation carefully managed



5 Freezing injury is exacerbated by waterlogged containers and beds – subjects like *Lavendula* are particularly vulnerable

**Table 1 Root killing temperatures of container grown nursery stock**

Species	Root killing temperature	Species	Root killing temperature
<b>0°C to -5°C range</b>			
<i>Buxus sempervirens</i>	-3	<i>Ilex cornuta</i>	-5
<i>Cotoneaster congestus</i>	-4	<i>Ilex crenata</i>	-5
<i>Cotoneaster dammeri</i>	-5	<i>Ilex opaca</i>	-5
<i>Daphne cneorum</i>	-5	<i>Magnolia x soulangeana</i>	-5
<i>Euonymus fortunei</i> 'Variegatus'	-5	<i>Mahonia bealei</i>	-5
<i>Hypericum</i> spp.	-5	<i>Pyracantha coccinea</i> 'Lalandei'	-5
<b>-5°C to -10°C range</b>			
<i>Cornus florida</i>	-6	<i>Ilex glabra</i>	-9
<i>Euonymus patens</i>	-6	<i>Koelreuteria paniculata</i>	-9
<i>Magnolia stellata</i>	-6	<i>Viburnum carlesii</i>	-9
<i>Rhododendron prunifolium</i>	-7	<i>Acer palmatum</i> f. <i>atropurpureum</i>	-9
<i>Viburnum plicatum tomentosum</i>	-7	<i>Kalmia latifolia</i>	-9
<i>Euonymus alatus</i>	-7	<i>Pachysandra terminalis</i>	-9
<i>Stephanandra incisa</i>	-8	<i>Pieris japonica</i>	-9
<i>Cotoneaster horizontalis</i>	-8	<i>Rhododendron schlippenbachii</i>	-9
<i>Cryptomeria japonica</i>	-8	<i>Vinca minor</i>	-9
<i>Taxus x media</i> 'Hicksii'	-8	<i>Cytisus x praecox</i>	-9
<b>-10°C to -15°C range</b>			
<i>Juniperus conferta</i>	-11	<i>Mahonia aquifolium</i>	-12
<i>Juniperus horizontalis</i> 'Plumosa'	-11	<i>Thuja occidentalis</i>	-12
<i>Juniperus squamata</i>	-11	<i>Euonymus fortunei</i> 'Coloratus'	-15
<i>Taxus x media</i> 'Nigra'	-11	<i>Leucothoe fontanesiana</i>	-15
<b>-15°C to -25°C range</b>			
<i>Juniperus horizontalis</i> 'Douglasii'	-18	<i>Picea glauca</i>	-23
<i>Rhododendron carolinianum</i>	-18	<i>Picea omorika</i>	-23
<i>Rhododendron catawbiense</i>	-18	<i>Potentilla fruticosa</i>	-23

Source: USDA/ADAS

## Wind chill damage

Strong winds combined with low, freezing temperatures also cause plant damage, sometimes referred to as 'wind chill'. Typical symptoms include extensive leaf necrosis, browning and a 'scorched' appearance to the foliage of the plant. Wind frosts too can be very damaging to the foliage of broad-leaved evergreen subjects and damage flower buds so reducing saleability, particularly of spring flowering varieties such as *Camellia*, *Magnolia* and *Rhododendron*. Adequate shelter is essential for these subjects.

## Root killing temperatures

Clearly, the hardiness of different nursery stock subjects determines their ability to tolerate and survive freezing temperatures. Similarly, the roots of some subjects are less able to survive sustained periods of low temperature and so are more susceptible to damage. Damaged roots typically turn soft and quickly discolour. Disease infection may follow.

Table 1 overleaf highlights the considerable variation in the 'root hardiness' of different subjects; -5°C seems to be the key threshold for many nursery stock

subjects below which root damage is likely to be more serious. Subjects with fleshy roots such as *Magnolia* are particularly susceptible. This should be considered when prioritising container stock for over-wintering under protection particularly if space is limited and when allocating bed space at potting.

## Desiccation

Sometimes referred to as 'physiological drought', winter damage caused by desiccation is quite common and most frequently seen amongst upright conifers (including many hedging varieties) and broad leaved evergreen subjects such as *Viburnum tinus*, *Mahonia*, *Camellia* and *Aucuba*. Foliage usually discolours, turns brown quite quickly and often appears scorched.

Desiccation or 'wind scorch' occurs when water uptake by the roots is exceeded by water loss from the leaves and stems. It is exacerbated by strong persistent cold winds and bright winter sunshine when the root-ball is frozen, thereby limiting the plants ability to replace water lost from the top growth. Deciduous subjects such as roses can also be affected.

## Physical damage

This is the most immediately obvious and usually easily seen cause of winter injury to container grown plants. Saleability of finished container stock is immediately affected and secondary damage from disease entry via wound tissue can establish quickly leading to further losses. Heavy loads of snow and ice or persistent strong winds can quickly break branches.



6 Brown discolouration on conifers is a classic symptom of desiccation and is exacerbated by strong, cold winds and bright sun

## Nursery stock requiring winter protection

Table 2 summarises nursery stock subjects which are known to be particularly susceptible to winter injury when grown in containers and so usually require over-wintering under the protection of fleece covers (outdoors), polythene or glass.

Table 2 Container grown nursery stock requiring winter protection

<i>Arbutus</i>	<i>Genista</i>	<i>Prunus laurocerasus</i>
<i>Aucuba</i>	<i>Griselinia</i>	<i>Prunus lusitanica</i>
<i>Azalea</i> (evergreen vars)	<i>Halimocistus</i>	<i>Pyracantha</i>
<i>Berberis</i> (evergreen vars)	<i>Hebe</i>	<i>Rhododendron</i>
<i>Calluna</i>	<i>Hedera</i>	<i>Rosmarinus</i>
<i>Camellia</i>	<i>Hydrangea</i>	<i>Senecio</i>
<i>Campsis</i>	<i>Ilex</i>	<i>Solanum</i>
<i>Caryopteris</i>	<i>Jasminum</i>	<i>Viburnum tinus</i>
<i>Ceanothus</i>	<i>Laurus nobilis</i>	
<i>Choisya</i>	<i>Lavatera</i>	
<i>Cistus</i>	<i>Lavendula</i>	
<i>Cordyline</i>	<i>Liquidambar</i>	
<i>Convolvulus cneorum</i>	<i>Leptospermum</i>	
<i>Cytisus</i>	<i>Magnolia</i>	
<i>Escallonia</i>	<i>Mahonia</i>	
<i>Eucalyptus</i>	<i>Osmanthus</i>	
<i>Eucryphia</i>	<i>Olearia</i>	
<i>Fremontodendron</i>	<i>Pernettya</i>	
<i>Fuchsia</i>	<i>Pieris</i>	
<i>Garrya</i>	<i>Phormium</i>	

Source: ADAS

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## Acclimatisation

The way in which woody plants naturally acclimatise or prepare for the winter months, confers a profound effect on their ability to survive during the winter. It is essentially a two stage process, short days promote dormancy, and reduced temperatures trigger changes in sugar and protein levels which collectively improve the plants resistance to injury from freezing.

Where winters are preceded by extended, mild autumns and freezing temperatures arrive suddenly, stock will be insufficiently acclimatised.

Nursery practice, as the winter months approach, should aim to replicate the process of natural acclimatisation as far as possible. Practical steps that can be taken include:

- Careful irrigation, if in doubt refrain from doing it
- Avoidance of high nitrogen feeds which promote soft growth liable to-damage
- Ensuring container beds and growing media drain freely to promote strong root development
- Allowing plants to 'harden up' naturally, before bringing them inside
- Keeping tunnels and glasshouses well vented to promote good air movement, using fans where necessary. This will also reduce *Botrytis* infection
- Using fleece covers to accelerate root development of autumn potted crops
- Avoidance of hard pruning late in the season; it can promote soft growth liable to injury.

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## Protecting container stock against winter-injury

### Site selection

When establishing new container units or expanding existing facilities, avoid exposed sites and frost pockets. Ideally, choose well sheltered areas which have a degree of natural wind protection. Well drained sites and container beds are also important in reducing winter losses through waterlogged container stock.

### Weather reports

Check local and national weather reports regularly so that appropriate measures can be taken promptly to protect container stock from adverse conditions such as severe frosts, strong

winds and heavy rain. Have fleece covers ready to provide immediate short term protection.

### Think ahead

Ensure all protected structures are in good condition well before the winter period, eg tunnel cladding. Make sure land drains and surface drainage channels are running freely.

### Potting

Plan potting schedules to ensure stock is adequately established for the winter period; where practical, schedule slow growing or sensitive subjects to be potted early to make maximum use of the growing season. Ideally, autumn potted container stock should be housed under protection, otherwise use fleece covers to hasten

root establishment. Winter potting is best avoided unless plants are well established and can be adequately protected during sustained spells of very wet or cold weather.

Think carefully about location when allocating bed space at potting, ensuring stock requiring winter protection is set down in sheltered areas on well drained beds which are either under protection or can easily be covered as necessary.

### Windbreaks

Good windbreaks reduce wind speed, desiccation and blowing over of pots. They should be designed and installed as part of the nursery layout. Use a combination of perimeter and internal windbreaks for maximum protection; natural, living windbreaks are usually cheaper than using artificial materials and though take longer to establish and



7 Adequate shelter from strong winds is essential; use living windbreaks for larger perimeter areas



8 Straw bales wrapped in plastic provide useful additional winter protection

provide shelter, are usually preferred for peripheral areas. Smaller, internal windbreaks provide additional shelter and are useful for breaking up the container unit into smaller, more manageable areas. They do though need to be carefully sited so as not to cause obstructions with irrigation, spraying or handling operations.

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## Drainage and growing-media

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Good drainage and well established root systems are the key to successful over-wintering of container stock. Beds and surrounding drainage channels must be well drained; drained capillary sand-beds remove free water quickly and are ideal.

Growing media must also be well structured, not liable to slump and should combine moisture retention in summer with good drainage in winter. Drained sandbeds allow more tolerance with the structure of the growing media; plants stood down on gravel or matting bases over winter require a more open structure with greater air capacity. The inclusion of graded pine bark in the potting mix will help retain a more open structure and is ideal for over-wintered subjects needing good drainage.

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## Nutrition

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It is important that container stock entering the winter period is in good condition and has a balanced nutritional status with adequate nutrient reserves in the growing media.

Plants which are starved of nutrition are more susceptible to winter damage and disease entry. High nitrogen feeds that encourage soft growth should cease during the autumn. Similarly, the use of single season quick release controlled release fertilisers and quick start fertilisers should be moderated for autumn potted material. Liquid feed nutrient ratios should be balanced and adjusted to supply adequate levels of potash to promote winter hardiness.

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## Irrigation

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Excess water is the single biggest killer of hardy nursery stock particularly during the winter months and moderating irrigation levels during the autumn period as winter approaches is an essential part of the acclimatisation process. Particular care is required with autumn potted container stock in order to promote rapid and strong root growth before winter.

Growing media must also be well structured and provide good drainage especially for container stock over-wintered outdoors on beds lacking positive drainage. Irrigation programmes should be checked and adjusted as light levels, day-lengths and temperatures diminish.

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## Anti-transpirants and thermal blankets

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Anti-transpirant products are not widely used in the UK although some growers in the eastern counties and near to exposed coastal districts favour their use with evergreen

subjects and conifer varieties. Horticultural fleece covers are usually preferred and work well providing they are well secured. Several layers of such covers are sometimes used to form 'thermal blankets' over container plants for additional protection during very cold spells.

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## Pot spacing

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Setting down or 'gapping up' container stock pot thick is a quick and easy means of providing added root protection over winter. It has the effect of reducing the surface area of containers exposed to the cold and provides added insulation to minimise damage to root systems. Similarly, double or even triple stacking of container stock where space is limited provides extra winter protection but should only be considered for established, durable plants with sturdy branch frameworks and usually under protection. Such stock must also be regularly checked over the winter for *Botrytis* and promptly 'de-stacked' and spaced in spring, otherwise plants will quickly deteriorate.

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## Weed control

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Weed competition for light, moisture and nutrients is very damaging to a plants natural resistance to winter injury and so maintaining high levels of weed control during the growing season is important.



9 Fleece covers are a useful means of providing additional protection; typically such covers provide frost protection to 3°C, more if double layers are used



10 Gapping up container plants in winter is a cheap and easy way of insulating root systems against the cold

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## Protection with structures

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Some nursery stock subjects must be protected to ensure their survival over winter and good spring growth. Typically, this would include most of the plants listed in Table 2 as well as plug plants and pot liners.

When over-wintering such plants inside, the priority is to maintain frost-free conditions and avoid soft growth, so adequate ventilation is important to keep the plants hardy. Traditionally, glasshouses have provided the best conditions; they retain heat well, can be easily ventilated, have good light transmission and with adequate heating, will give protection during the hardest of UK winters. Control systems should be set to maintain a temperature of between  $-1^{\circ}\text{C}$  and  $+5^{\circ}\text{C}$ .

Additional heating should be considered during very cold spells and for less hardy subjects; lifting the air

temperature by  $5^{\circ}\text{C}$  provides valuable, additional protection. Warm air heaters used with fans make a great difference to protecting young nursery stock. Lower cost installations would include bottled gas and burners with fans to maintain air movement and avoid localised hot spots.

Double skinned polythene tunnels using electric fans to separate the skins and so provide insulation, can protect against  $5^{\circ}\text{C}$  of frost. Single skin tunnels whilst usually providing adequate shelter from strong, cold winds only offer marginal protection against the cold. In severe weather, extra insulation is required and protective fleeces or similar covering materials should be used over the plants to enhance frost protection. Draughts should be sealed as much as possible. Net tunnels favoured for shade loving subjects in summer provide little protection against low

temperatures and container stock in such structures are vulnerable to water-logging. If possible, such tunnels should be covered with a polythene skin for added protection over winter.

Nursery stock tunnels must be well ventilated and those with net and wind-down polythene sides (as opposed to wind-up sides which can expose ground levels crops to wind chill) are preferred. Modern, high-sided tunnel structures with enhanced side and roof ventilation provide ideal conditions for over-wintering container stock. However, they are quite costly and cheaper alternative methods of winter protection need to be considered alongside these.



11 Glasshouse control systems should be set to maintain a temperature between  $-1^{\circ}\text{C}$  and  $+5^{\circ}\text{C}$



12 Fan ventilation is an effective way of providing good air movement to help combat *Botrytis*, particularly in larger structures

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## Action points

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### Planning ahead

- Select new container sites carefully when planning new production units or expanding; harness natural shelter and avoid very open, exposed sites
- Choose a well structured growing media with good drainage characteristics. Consider the inclusion of graded pine bark to help retain an open structure
- Where protected space is limited, prioritise container stock to over-winter inside and plan bed space well

in advance. Ensure heating systems work and are in good condition. Propagation beds and liners are high value and particularly vulnerable

- Use adequate windbreaks and ensure these are kept in good condition to reduce desiccation and physical injury over winter. In open ground situations, consider using straw bales as an insulating barrier around container beds
- Where appropriate, gap up container stock pot thick to provide added root protection and use fleece covers to protect from cold winds and frosts.

During very cold snaps, use several layers of fleece for extra protection.

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### Acclimatisation

- Ensure container stock enters the winter period properly acclimatised and in good condition with adequate nutrient reserves and good drainage
- Avoid high nitrogen feeds for autumn potted material as these encourage soft growth
- Avoid winter potting and hard pruning where this may predispose plants to frost damage, ie late flushes of soft growth

- Avoid bringing outdoor container stock inside too early for the winter period otherwise, soft autumn growth more liable to winter injury will result.

### Water management

- Excess water is the single biggest cause of winter losses in HNS so it is essential to moderate irrigation regimes as winter approaches and ensure good drainage conditions prevail.
- Ensure container beds are maintained in good condition and are well drained; drained capillary sand-beds are ideal especially for moisture sensitive subjects and liners.

### Stay vigilant

- Check local and national weather reports so that appropriate measures to protect container stock can be taken promptly
- Be vigilant about disease attack and combine cultural control measures with a balanced approach to fungicide use. Pay particular attention to *Botrytis*
- Ventilate polythene tunnels, glasshouses and thermal covers as conditions allow to control *Botrytis* and maintain winter hardiness. Fan ventilation should be considered in larger houses and multi-span structures

- Maintain effective weed control to reduce competition for light, water and nutrients.

### Structures

- If using glasshouses, set temperatures to between -1°C and +5°C. Supply additional heat (up to 5°C) during very cold spells. Use fans to maintain air movement and avoid localised hot spots
- Use double skinned tunnels to provide protection, typically down to 5°C. They can also be useful for wind protection, but use fleeces or other materials for extra insulation
- If possible, cover net tunnels with a polythene skin.



13 Low tunnel structures over outdoor beds make good use of space and can be temporarily covered in winter to offer valuable, cost effective protection



14 Sub-irrigated, drained sand beds provide ideal container beds for overwintering plants

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