Factsheet 04/13
(HDC projects PO 004 and HNS 103b)

Protected Ornamentals

Ornamental plant production: The use of chemical plant growth regulators on protected crops

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This factsheet provides guidance on the use of chemical plant growth regulators and highlights the findings of recent HDC funded trials of chemical products new to ornamental horticulture.

Action points

- Plant species and cultivars all respond differently to chemical plant growth regulators (PGRs), therefore small scale trials should be conducted prior to widespread use on new plant subjects.
- Check product labels for crop-specific information on effectiveness and phytotoxicity and any operator safety requirements.
- To maximise their effect, PGRs should be applied to new growth prior to any rapid extension.
- Apply PGRs under dull, cool conditions, ideally late in the afternoon or early in the evening to prevent rapid drying of the leaf surface and to ensure adequate leaf absorption.
- Do not treat plants when under stress.
- Make sure plants are well irrigated prior to treatment to avoid the need for irrigation soon after treatment. This will minimise the risk of washing the PGR off the leaves into the growing media, increasing the effect.

1. The result of effective applications of a chemical plant regulator on *Dahlia* (left and middle) to manipulate plant growth

Background

Controlling plant growth and development is essential for the production of quality plants to a schedule. Best practice requires that cultural and physical methods of growth control be considered first in preference to any chemical application. However, these techniques alone may be insufficient and often a combination of cultural and chemical growth control need to be integrated into any production programme.

Chemical plant growth regulators (PGRs) can produce a rapid, precise plant response and as such can be used both proactively and reactively when scheduling crops or when holding crops back in response to sudden changes in demand or the unseasonal effects of weather.

PGRs can be used to:

- Manipulate plant growth and improve habit.
- Schedule and hold back crops.
- Induce, advance or delay the onset of flowering or cause flower abortion where required (as in the case of stock plant management).
- Improve other plant aspects such as leaf colour or reduce leaf size.

PGRs deliver a range of commercial benefits, including:

- Reduced labour costs during production (less of a need for pinching in production and hand cleaning plants at dispatch).
- Reduced crop wastage through improved scheduling and improved grade out.
- Reduced transport cost by potentially permitting more plants per trolley.
- Reduced water use.
- Potential for increased crop production (more plants per square metre).

There are however a number of concerns relating to the use of PGRs:

- Potential phytotoxicity if used incorrectly.
- Variable crop response.
- Persistence in inert materials and growing media.
- Increased reliance on pesticides.

The main PGRs currently authorised and used on ornamentals in the UK include: chlormequat (numerous formulations), daminozide (B-Nine SG and Dazide Enhance) and paclobutrazol (Bonzi and Pirouette).

Aiming to broaden the range of PGRs available to growers, the HDC recently commissioned trials to evaluate potential alternative chemicals for use on bedding plants (HDC project PO 004) and herbaceous perennials (HDC project HNS 103b). Products examined included: Regalis (prohexadione-calcium), Cerone (ethephon or 2-chloroethylphosphonic acid) and Moddus (trinexapac-ethyl). The trials also highlighted the growth regulatory effects of certain triazole fungicides that need to be taken into account when planning the application of PGRs.

Cultural and physical methods of growth control

Temperature

Plant species should be grouped and grown according to their temperature requirements, thereby preventing excessive extension growth under inappropriate conditions. For example *Alyssum, Antirrhinum, Dianthus,* and *Mimulus* have a cool temperature requirement (5-10ºC); *Dahlia, Fuchsia* and *Verbena* have a moderate temperature requirement (10-15ºC), and *Begonia, Impatiens* and *Salvia* require warm temperatures of at least 15ºC.

DIF and DROP techniques use the difference between day and night temperatures or a drop in temperature at dawn to control stretch in many plant species. More compact plants are produced when night temperatures are equal to (zero DIF) or warmer than (negative DIF) day temperatures as stem elongation is reduced. However, when day temperatures are warmer than night temperatures (positive DIF), stem stretch increases.

Ventilation can be used to impose an abrupt dip in air temperature for 2-3 hours at dawn (DROP) to produce the DIF effect. A combination of DIF and DROP can also be used to produce compact plants of some varieties.

The effectiveness of these treatments is dependent on the size, duration and timing of the temperature drop, and can be limited by external temperatures. DIF and DROP both need to be continued until marketing to maintain the effect. Plant species responsive to these treatments include: *Ageratum, Cyclamen, Dahlia, Dianthus* and *Salvia. Alyssum, Lobelia, Marigold* and New Guinea impatiens are less responsive. Pansy is responsive to a combination of DIF and DROP.

Light

Light intensity has a positive effect on plant growth; however different plant species have different optimum light levels for growth and development. Light levels that are too low result in plants becoming etiolated. Conversely, high light levels increase growth rate, but excessive light levels can cause scorch.

Light quality influences stem extension and branching. Within the plant canopy, leaves filter out red light, leaving a greater proportion of far-red light compared to red light, stimulating plants to stretch to reach the light. A higher ratio of red to far-red reduces stem elongation and increases branching through reduced apical dominance. Similarly, higher levels of blue light reduce stretch. There is natural variation in light quality through the day, with the red to far-red ratio decreasing towards the end of the day, producing plants with longer internodes and less branching. Variation in light quality can also be expected due to season and latitude.

Spectral filters (modified plastics) have been developed that modify plant architecture by altering the light spectrum reaching the crop (HDC projects PC 150 and CP 19). Most varieties of bedding plants grown under Solatrol, a green tinted plastic which

filters out far-red light (thereby increasing the red: far-red ratio), were more compact and showed increased branching and leaf area. *Dianthus,* Pansy and *Petunia*, showed greatest response in trials (HDC project CP 19). However, responses did vary; seed-raised geraniums and marigolds showed little or no response, while plant height and stem elongation increased in *Antirrhinum* 'Liberty' and *Fuchsia* 'Brutus'. Solatrol also affected flowering time, delaying flowering in *Antirrhinum*, *Fuchsia* 'Brutus' and blue pansy, and advancing flowering in Fuchsia 'Helen Fahey' and *Impatiens* 'Expo-select'. UV-T (UV transparent) plastic transmits the full UV spectrum and produced compact growth in most varieties, increasing the intensity of flower and leaf colour, leaf thickness and general hardiness of plant tissue.

Nutrition

Growth can be controlled by varying the nutrient application rate (low levels of base fertiliser prevent rapid early growth), supplementing programmes with liquid feeds (to match feed levels to crop development), using controlled release fertiliser (to provide nutrients as required) or amending the growing media with bark (to absorb excess nutrients). However, care does need to be taken when using these techniques to avoid deficiency symptoms.

2. Starved geranium seedlings showing pale green/yellow leaves with some red colouration on the older leaves due to nitrogen deficiency

The nutrient balance of fertilisers can also be managed to reduce excess growth:

- Use low ammonium fertilisers during the winter in dull weather conditions, and keep the proportion of ammonium nitrogen below 50% of the total nitrogen supplied.
- Use potassium and calcium nitrate as sources of nitrogen to promote balanced growth.
- A P-buffer (Compalox-P, 1-2%) may be incorporated into the growing media as the sole source of phosphorus. Reduced phosphorus levels in the growing media will produce shorter plants, enhance root development, and improve shelf life.

Irrigation

Water deficit stress can be used to slow growth and produce more compact plants (a 10-30% reduction in growth is achievable), better root growth and improved shelf life in most plant species (for example *Impatiens* and Poinsettia). Watering plants little and often, and allowing plants to reach wilting point before re-watering is most effective, although overuse of drought stress can affect plant quality and cause premature bud development in plug plants or bud drop in a range of species including *Fuchsia* and New Guinea impatiens.

3. Calibracoa plant quality adversely affected by overuse of water deficit stress

Thigmotropism

Vibration, shaking or brushing with a solid object (thigmotropism), such as netting, or even air movement will produce more compact plants, although the effects are variable between plant species, with no response shown by some species. The effect is thought to be due to ethylene production in response to mechanical stress.

Chemical plant growth regulators

Mode of action

Chlormequat, daminozide, paclobutrazol, prohexadione-calcium and trinexapac-ethyl all act by inhibiting the biosynthesis of gibberellin (a natural plant growth hormone), although generally at different stages of its production resulting in slightly different effects within the plant. Ethephon (2-chloroethylphosphonic acid) is an organophosphate, it penetrates plant tissue and is translocated around the plant, where it breaks down generating ethylene. Ethylene affects various plant growth processes including flowering and lateral branching in ornamentals.

Approval status

Table 1 (Tables 1-7 are reproduced in the separate sheet at the back of the factsheet) summarises the active ingredients which are authorised within the UK for use as PGRs on ornamental crops under protection: chlormequat, daminozide, ethephon (2-chloroethylphosphonic acid), paclobutrazol, trinexapac-ethyl. Prohexadione-calcium is approved for use on outdoor ornamentals only.

Active ingredients

Chlormequat

Application of chlormequat results in shorter internodes and thicker, darker green leaves. It is used to improve plant habit and increase branching early in the production phase, particularly during *Pelargonium* production. Use can also advance flowering (by up to 10 days) and marketing, depending upon the crop. Chlormequat is commonly used on geranium, *Osteospermum* and poinsettia.

Chlormequat is absorbed via leaves and roots and so may be applied either as a foliar spray or drench. It is systemic and highly mobile within the plant and is passively absorbed by all plant tissues. However, as chlormequat is water soluble, uptake through the waxy cuticle of leaves can be relatively slow and only occurs when the foliage is wet. Use of a non-ionic wetting agent generally improves foliar uptake, enabling application rates to be reduced, thereby reducing the potential for leaf yellowing (chlorotic spotting/marginal leaf chlorosis). Activity is reduced by low temperature, and crops are less responsive below 10°C.

Chlormequat is available in various formulations and concentrations ranging between 460-750g/l; the rate should be adjusted depending on the formulation used (see Table 2). Application should be carried out late in the day or when leaves are likely to stay wet for several hours. As chlormequat is only active in the plant for a short period, repeat treatments are necessary every 10-14 days.

Daminozide

Two products containing daminozide are authorised for use on protected ornamentals within the UK: B-Nine SG and Dazide Enhance. Daminozide application reduces internode elongation, producing more compact plants with stronger stems, darker green foliage (due to increased chlorophyll concentration), better developed root systems and reduced leaf area in some plant species. Daminozide also increases lateral branching, resulting in increased flower production; application can delay flowering for up to five days, although this does differ between species and cultivars.

As with chlormequat, daminozide is water soluble, therefore uptake through the waxy leaf cuticle is slow and products should be applied during periods of high humidity or at the end of the day, onto dry foliage, however, it is highly mobile once it has been absorbed and it quickly moves throughout the plant.

Recent work (HDC project HNS 103b) demonstrated that daminozide is not only absorbed by leaves as previously thought, but also via roots. Drenches of daminozide reduced the plant growth of some plants (such as *Achillea* and *Salvia*) by almost 50%. Activity is reduced at high temperatures or where growth is vigorous.

4. Recent HDC work (HNS 103b) has demonstrated that daminozide is absorbed by both leaves and roots

Daminozide is generally used to fine tune growth as it provides only moderate growth control and the effect is less persistent than chlormequat or paclobutrazol (Table 3). Products are also relatively expensive.

In 2010, the Chemicals Regulation Directorate (CRD) stipulated re-entry periods for daminozide products approved for use within the UK, although they have now been removed from both products. Re-entry periods were introduced in response to EU legislation to prevent work being carried out where there is a risk of staff exposure to pesticides through contact with treated plant material. They are usually set if pesticides have a low operator exposure level, are absorbed via the skin or if people are in contact with residues on treated surfaces.

Ethephon (2-chloroethylphosphonic acid)

Cerone is the only product authorised for use in the UK containing ethephon via the off-label approvals (EAMUs) 2366/12 and 2364/12. It was previously marketed as Ethrel C, which was traditionally used to increase branching, stimulate basal bud production and abort flower buds, thereby increasing cutting yield on stock plants (Table 4). Cerone may be a suitable alternative to chlormequat early in the production cycle where plants do not respond to chlormequat. Cerone is most effective at temperatures over 10°C.

Paclobutrazol

Bonzi and Pirouette are the only products containing paclobutrazol authorised for use on ornamentals within the UK. Application results in reduced cell division and elongation, reduced leaf area and improved leaf colour (and bract colour in some red poinsettia cultivars) but has little effect on leaf production, branching or root growth. Paclobutrazol is upwardly systemic within the plant. It is rapidly taken up, primarily through stems (but also leaves and roots) but is not readily transported within the plant, therefore good coverage of stems and leaves is necessary for effective growth control. It is effective once the spray dries and will not wash off the foliage after approximately 30 minutes.

Applications to maturing plants can reduce both flower size and flower stem length impacting on appearance. However, this product is particularly useful for holding plants back which are close to the point of marketing (see Table 5).

Prohexadione-calcium

Prohexadione-calcium, marketed as Regalis, is authorised for use on outdoor ornamental crops only in the UK (via EAMU 2866/08). Although in the same chemical group as daminozide and trinexpac-ethyl, it is more active. Limited trials have indicated that Regalis produces compact growth with some bedding plant species. However, it also affects anthocyanin formation, which can result in flower petal bleach in some plant species. Early application in the production phase may limit this negative side effect and is likely to achieve the best growth regulation (see Table 6). A water conditioner must be used with Regalis (X-Change at a rate of 1 litre in 400 litres water).

Trinexapac-ethyl

Trinexapac-ethyl, marketed as Moddus, is used to control stem height and lodging in cereals. Chemically related to prohexadione-calcium and daminozide, it can cause more severe petal bleach than Regalis in some species. It currently possesses an off-label approval (EAMU 3062/10) for use in ornamental plant production (Table 7).

PGR application

PGR applications need to be planned to ensure that plant subjects are in an appropriate condition for safe, effective treatment.

- PGRs should be applied to established, well watered plants with dry foliage under dull conditions and in high humidity.
- PGRs should not be applied to plants that are pot bound, under water, nutrient or any other type of stress.
- Treatments should not be made in bright sunlight to avoid the risk of phytotoxicity.

To ensure that any growth regulatory effects can be reproduced and that the causes of any issues that may arise can be easily determined, maintain detailed records of applications including: dose rates, plant species, growth stage and environmental conditions. Determine the effectiveness of treatments by recording crop development and leave a few plants untreated for comparison.

Refer to appropriate product labels/technical information or EAMUs prior to application to determine the relevant or maximum dose rate, frequency of application, water volume and crop specific information for the product being applied.

Timing

PGR applications should be made at the appropriate growth stage for the plant variety and the crop's physiological condition such as leaf number, plant size or side shoot development. If applied too soon, plant growth may stop completely rather than be controlled in a balanced way. Conversely, late application can result in delayed flowering and reduced flower size, or reduced bract size and delayed bract colour development in the case of poinsettia.

To maximise their effect, PGRs should be applied to new growth prior to any rapid stem extension or at the very first signs of flower bud initiation stage when the objective is to reduce flower stem length.

PGRs are normally applied as repeated low rate treatments as this allows applications to be fine-tuned to growing conditions. When applied every 7–14 days a 15-30% reduction in plant

5. PGRs should be applied at the correct plant growth stage, before rapid extension: *Dahlia*, *Fuchsia* and geranium

height can be achieved. Alternatively a single high rate application can be made, but this approach carries more risk and can be excessive under cool, dull conditions. Plants tend to return to their normal growth rates within 2-4 weeks after foliar application of PGRs.

To ensure maximum efficacy of PGRs, they should be applied late in the afternoon or early in the evening to prevent rapid evaporation from the leaf surface and to allow the chemical to be absorbed slowly by the plant overnight. The use of shade screens can also help to prevent evaporation of the applied product prior to leaf uptake, and avoid scorch where bright conditions continue post application.

Application method

PGRs can be applied either as sprays or drenches, depending on their mode of action. Although spray applications tend to have less impact on plant growth compared to drenches they are easier to fine-tune through repeat applications. Spray applications are also less expensive to apply than drenches due to the lower labour costs involved.

Foliar sprays

Foliar sprays require even application for consistent results. This is best achieved by applying a known water volume and rate to a known area for reproducible results. Sprays should be applied to the point of run-off, which is the point when foliage is thoroughly covered and the solution just starts to drip; excess run-off should be avoided. Fine spray droplets generally achieve better coverage and canopy penetration.

Care must be taken when applying paclobutrazol. Low spray volumes may result in poor coverage, insufficient growth control and increased variability within the crop. Conversely applying too high a spray volume can result in spray running into the growing medium which can have a persistent effect.

Care should be taken to avoid root uptake when treating plugs or recently potted crops with a large exposed surface area of growing medium, by delaying application until the plant's foliage has covered some of the surface. Too high a rate or volume can also effectively stop plant growth, which can render crops unsaleable, particularly young plants, early on in the production phase.

In general, irrigation should not be applied for 24 hours post application, although label recommendations are for shorter time periods for chlormequat products (12-18 hrs) and Cerone (rain-fast within 4-6 hours).

Drench application

Although time consuming, drenches are easier to apply evenly than foliar sprays providing there is adequate, evenly distributed moisture within the growing medium. Drenches are applied by volume, depending on pot size. Drenches should be applied when roots are actively growing to enable uptake. Wash any excess growth regulator off the leaves to avoid chlorosis.

PGRs with root activity are generally more potent when applied to the growing medium as a drench than as a foliar spray. For drench applications, avoid irrigating crops too soon after application.

A drop in temperature post application (spray or drench) can also enhance the effect of the PGR, resulting in a more powerful reduction in growth.

Adjuvants

Chlormequat – use of a non-ionic wetter is recommended with chlormequat to minimise phytotoxicity.

Daminozide and paclobutrazol – the label for most of these products states that they should not be mixed with other chemicals, including adjuvants.

Prohexadione calcium – a water conditioner must be used, the recommendation is X-Change at a rate of 1 litre in 400 litres.

Dose rate calculations

Rates of plant growth regulators are sometimes given in parts per million (ppm). The correct quantity of product based on active ingredient ppm can be calculated as follows:

Fargro Chlormequat (46%)

To calculate 500 ppm active ingredient (ai):

$$500 \text{ ppm ai} = 500 \times \frac{100}{46} = 1087 \text{ ppm commercial product}$$

To convert to ml/litre:

$$\frac{1087}{1000} = 1.08 \text{ ml product /litre.}$$

Stabilan 750 (75%)

To calculate 500 ppm active ingredient (ai):

$$500\text{ppm ai} = 500 \times \frac{100}{75} = 666.6 \text{ ppm commercial product}$$

To convert to ml/litre:

$$\frac{666.6}{1000} = 0.66 \text{ ml product/litre}$$

Plant species

Different plant species and cultivars can vary in their response to the different PGR active ingredients, therefore it is necessary to identify which plants respond to which active ingredients and determine the appropriate application rate to obtain optimum results.

Growers should be cautious when interpreting results from overseas as the climate and growing conditions can be very different from the UK. Rates from the southern states of the USA, for example, should not be considered as they may be too high, resulting in excessive growth regulation when used in the UK.

Plant specific information can be found on product labels, off-label approvals and company technical information. Table 8 (overleaf) summarises which PGRs have been effective on which plant species, the information presented was derived from a number of sources.

Table 8. Summary of responsive plant species by PGR active ingredient

Chlormequat	Daminozide	Ethephon	Paclobutrazol	Prohexadione -calcium*	Trinexapac -ethyl
Various	B-Nine SG/Dazide Enhance	Cerone	Bonzi/Pirouette	Regalis	Moddus
Achillea	*Alyssum*	*Achillea*	*Achillea*	*Achillea*	*Achillea*
Ageratum	*Ageratum*	*Begonia*	*Ageratum*	*Ageratum*	*Begonia*
Antirrhinum	*Antirrhinum*	*Dahlia*	*Alyssum*	*Begonia*	*Fuchsia*
Celosia	*Aster*	*Dianthus*	*Begonia*	*Bidens*	Geranium
Coreopsis	*Azalea*	*Fuchsia*	*Campanula*	*Coreopsis*	*Impatiens*
Diascia	*Brassica*	Geranium	*Celosia*	*Dahlia*	*Petunia*
Erysium	*Chrysanthemum*	*Impatiens*	*Chrysanthemum*	*Dianthus*	*Salvia*
Geranium	*Coleus*	*Lantana*	*Cineraria*	*Diascia*	
Impatiens	*Coreopsis*	*Pelargonium*	*Coreopsis*	*Dicentra*	
Lavatera	*Cosmos*	*Petunia*	*Dahlia*	*Fuchsia*	
Lobelia	*Dahlia*	*Tagetes*	*Dianthus*	Geranium	
Mimulus	*Diascia*	*Verbena*	*Diascia*	*Impatiens*	
Osteospermum	*Dicentra*		*Fuchsia*	*Petunia*	
Pansy	*Fuchsia*		Geranium	*Salvia*	
Pelargonium	Geranium		*Impatiens*	*Tagetes*	
Phlox	*Hydrangea*		*Kalanchoe*	*Verbena*	
Poinsettia	*Impatiens*		*Leucanthemum*		
Salvia	*Lobelia*		*Lobelia*		
Stocks	*Mesembryanthemum*		*Mesembryanthemum*		
Verbena	*Nasturtium*		*Nemesia*		
Wallflower	*Nemesia*		New Guinea impatiens		
	Nicotiana		*Ostespermum*		
	Nemesia		Pansy		
	Pansy		*Petunia*		
	Pelargonium		*Phlox*		
	Petunia		*Phygelius*		
	Phlox		Poinsettia		
	Salvia		*Rosa*		
	Sunflower		*Salvia*		
	Sweet pea		Stocks		
	Tagetes		*Tagetes*		
	Verbena		*Verbena*		
	Viola				
	Zinnia				

The information has been gathered from product labels, approval notices, ADAS Technical Sheet P3151, HDC projects PO 004 and HNS 103b (refer to the publications for more detailed information on cultivars used).

* Prohexadione-calcium is approved on outdoor ornamentals only. Always check the product label for advice relating to plant cultivars excluded from use.

Potential adverse effects of PGR applications

A number of adverse effects may be seen following inappropriate use of PGRs, many of which may be due to over application causing the product to run off into the growing medium, leading to excessive growth restriction as a result of root uptake. Paclobutrazol can bind to capillary matting, persisting in the growing environment where it remains active and may be responsible for problems in subsequent crops. It is also persistent in soils and can cause stunting in subsequent crops which root into the soil.

Phytotoxicity

Phytotoxic effects have been noted on some plant species following application of PGRs, including stunting, growing point distortion, dark foliage and leaf crinkling:

- Chlormequat can give rise to leaf edge yellowing, leaf spotting and crinkling when applied at high rates. Chlorosis can be minimised through the use of an approved non-ionic wetter.
- Daminozide can cause flower stem stunting and delay crops.
- Paclobutrazol application is most effective using drenches, but can be too severe. Phytotoxic effects include stunting, hardening of the growing point, leaf necrosis and leaf crinkling, particularly if applied to sensitive plants, such as *Begonia*. Stunting can be permanent, particularly where paclobutrazol is applied to young plants too soon.

6. Leaf margin chlorosis in geranium following a high rate chlormequat application

7. Severe stunting (left) in pansy following over application of paclobutrazol

Flowering

Delayed flowering was noted in some species following daminozide and paclobutrazol application in HDC project HNS 103b. Late application of PGRs can also result in reduced flower size and reduced flower stem length, so that the flowers are no longer held above the leaf canopy.

Petal bleach

Petal bleach has been observed in *Begonia*, *Dahlia*, *Verbena* and *Lavandula* following application of Moddus or Regalis. The effect is thought to be due to their impact on anthocyanin formation. Care should be taken when applying these products, earlier applications may limit the bleaching effect.

8. Petal bleach in *Verbena* in response to Moddus (left untreated, right treated)

Other chemicals that may affect plant growth

Some triazole and imidazole fungicides may also reduce plant growth. Growers should note that these fungicide products are authorised for disease control and are not authorised for plant growth regulation. Where these fungicides are routinely used in disease control programmes growers may need to reduce the rate of any plant growth regulators applied to avoid excessive growth control.

Table 9. Fungicides with growth regulatory effects

Group name	Chemical group	Active ingredient	Example product
Demethylation inhibitors	Triazoles	Myclobutanil	Systhane 20 EW
		Propiconazole	Bumper 250 EC
	Imidazoles	Prochloraz	Octave

The fungicides listed are those which may potentially have growth regulatory effects when used in disease control programmes. Other fungicides within these chemical groups also have the potential to cause some check to plant growth.

9. Bumper 250 EC can reduce plant growth in some plant species including *Begonia* (left untreated, right treated)

Further information

HDC Factsheets and publications

HDC Factsheet 14/06 (revised). 'Guidelines and best practice for pesticide spray application in protected ornamental crops'.

HDC Factsheet 01/02. 'Growth regulation of ornamental plants by reduced phosphorus 'P' availability'.

Spray Check. A tutorial DVD for spray operators.

HDC Grower summaries and reports

HDC Grower summary PO 004: 'Assessment of a number of new plant growth regulator products to control growth on commercial crops of bedding plants'.

HDC Grower summary HNS 103b: 'Hardy Herbaceous Perennials: Workshop to explore the potential for crop scheduling and the effects of plant growth regulators to optimize growth and habit'.

HDC Grower summary PC 150: 'Bedding plants: The use of spectral filters to regulate plant growth'.

HDC Grower summary CP 19: 'Horticultural crops: A demonstration of potential benefits of modified plastic crop covers'.

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Notes

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Product and rate information

Table 1. Plant growth regulators authorised for use in the UK

Active ingredient (A.I)	Product	A.I. content	Permitted on crops		Approval status
			Outdoor	Protected	
Chlormequat *	3C Chlormequat 720	720 g/l	✔	✔	Label approval for use on geranium, *Pelargonium* and Poinsettia
	3C Chlormequat 750	750 g/l	✔	✔	
	AgriGuard Chlormequat 720	720 g/l	✔	✔	
	AgriGuard Chlormequat 750	750 g/l	✔	✔	
	BASF 3C Chlormequat 720	720 g/l	✔	✔	
	BASF 3C Chlormequat 750	750 g/l	✔	✔	
	New 5C Cycocel	645 g/l	✔	✔	
	New 5C Quintacel	645 g/l	✔	✔	
	5C Quintacel	640 g/l	✔	✔	Label approval for use on ornamentals
	Fargro Chlormequat	460 g/l	✔	✔	
	Agrovista 3 See 750	750 g/l	✔	✔	Label approval for use in ornamental plant production
	CCC 720	720 g/l	✔	✔	
	Chlormequat 46	460 g/l	✔	✔	
	CS Chlormequat 750	750 g/l	✔	✔	
	Hive	730 g/l	✔	✔	
	Mirquat	730 g/l	✔	✔	
	Stabilan 700	700 g/l	✔	✔	
	Stabilan 750	750 g/l	✔	✔	
	Terbine	730 g/l	✔	✔	
Daminozide	B-Nine SG	85% w/w	-	✔	Label approval for use in ornamental plant production (protected crops only)
	Dazide Enhance	85% w/w	-	✔	
Ethephon (2-chloro-ethylphosphonic acid)	Cerone (MAPP 15944/15087)	480 g/l	✔	✔	EAMU 2366/12 and 2364/12 (ornamental plant production)
Paclobutrazol	Bonzi	4 g/l	✔	✔	Label approval for use in ornamental plant production (container grown crops only)
	Pirouette	4 g/l	✔	✔	
Prohexadione-calcium **	Regalis	100 g/kg	✔	-	EAMU 2866/08 (outdoor crops only)
Trinexapac-ethyl	Moddus	250 g/l	✔	✔	EAMU 3062/10 (ornamental plant production)

* Adjuvants: A suitable non-ionic surfactant should be used with chlormequat.
** A water conditioner must be used with Regalis e.g. X-Change at a rate of 1 litre in 400 litres.

Table 2. Commonly used rates of chlormequat (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Bedding plants	1.9 – 4.2 ml	Not always specified
Pelargonium	1.2 – 2.8 ml	2 - 3
Poinsettia	1.8 – 2.0 ml	3

* Always check individual product labels as the concentration of individual products vary. Most products also recommend the use of a non ionic wetter, more details can be found on the product label.

Table 3. Commonly used rates of daminozide (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Chrysanthemum (pot)	1.2 – 5.0g	2
Chrysanthemum (standard)	0.5 – 5.0g	2 – 3
Chrysanthemum (spray)	0.5 – 1.25g	2 after start of short days
Helianthus (sunflower)	4.0 g	3
Hydrangea macrophylla	4.0 g	3
Kalanchoe	1.0 – 3.0g	3
Potted ornamentals/bedding	0.5 – 5.0g	5
Petunia/calibrachoa	1.0 – 6.0g	5
Shrubs	1.0 – 5.0g	3

* Always check individual product labels as rates of individual products vary.

Table 4. Commonly used rates of ethephon (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Pelargonium	1.0 ml	1
Other ornamentals	8.0 ml	1

* Always obtain a copy of the EAMU for reference.

Table 5. Commonly used rates of paclobutrazol (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Azalea	25.0 ml	1
Bedding, *Begonia elatior*, *Kalanchoe* and poinsettia	1.25 ml	Repeat as necessary
Rosa	10.0 ml	2

* Always check individual product labels.

Table 6. Commonly used rates of prohexadione-calcium (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Outdoor ornamentals	1.25 ml**	2

* Always obtain a copy of the EAMU for reference.
** Based on applications in 1000 litres of water/ha.

Table 7. Commonly used rates of trinexapac-ethyl (as a foliar spray)

Subject	Rate per litre of water*	Maximum number of applications*
Ornamental plants	0.6 ml**	1

* Always obtain a copy of the relevant EAMU for reference.
** Based on applications in 1000 litres of water/ha.

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