

9. Using Plant Growth Regulators

Plant growth, especially vegetative growth, can be controlled by a number of cultural and environmental management strategies, as well as with chemical plant growth regulators (PGR). PGRs are chemicals that modify the natural hormonal activity that controls plant growth and development. The cultural and environmental factors that influence plant growth and development can also influence how a crop responds to a PGR. Most of the PGRs used in the greenhouse function as “growth retardants”. These PGRs reduce plant height by inhibiting the production of gibberellins, which are the hormones responsible for cell elongation. Their effect is primarily on stem, petiole and peduncle elongation. Leaf expansion may be reduced, resulting in smaller, thicker leaves with darker green colour leading to reduced water requirements due to lower transpiration rates.

Achieving the best plant response to PGRs requires integrating both the art and the science of growing. PGRs are not a substitute for good crop management practices and accurate environmental control.

Cultural Factors Influencing Plant Growth

Moisture stress

Growing a crop under low-level moisture stress, which can be accomplished by limiting the amount of available water within the growing substrate at any one time and as well as maintaining very low relative humidity, will reduce plant growth including leaf expansion. Typically this can only be achieved when hand watering or top watering with low-volume drippers.

Nutrition

Fertilizing with fertilizers containing ammonium or urea-based nitrogen sources promotes cell expansion and ultimately stem elongation. With many plant species, use of low (or zero) phosphorus fertilizers will reduce plant height without adversely affecting flowering. Thus, once plants are established, fertilizers

such as 15-0-15, 14-0-14, 13-2-13 can be used to control vegetative growth including stem elongation, leaf size and petiole length.

Average day (24-hour) temperature

Raising or lowering the average 24-hour temperature has an impact on plant height. For example, roses and “cool” crops such as anemone, ranunculus, primula and cineraria will remain short when grown at higher temperatures, while crops such as chrysanthemums and lilies are generally taller when grown at higher temperatures. Raising or lowering the average 24-hour temperature will increase or retard the rate of plant development.

Day/night temperature or DIF

DIF is defined as the day temperature minus the night temperature. The maintenance of a lower day than night temperature (negative DIF), or the provision of a sudden temperature drop to 12–13°C for 2–3 hours beginning at dawn, reduces stem elongation. This sudden change at first light influences gibberellin synthesis. Although effective height control can be achieved, use of very strong negative DIF over an extended period of time can result in leaf curling and leaf yellowing

Light intensity

Higher light intensities generally produce shorter plants in the greenhouse. Remove shading compounds by late summer and replace poly films every three years to allow maximum light to reach the crops within the greenhouse.

Light quality

The effect of end-of-day light quality on stem elongation is similar to the DIF effect. The ratio of red to far-red light (photomorphogenic light) affects stretching and branching. Removal of end-of-day twilight from the greenhouse through the use of blackout curtains increases the red/far-red light ratio compared to ambient light, and is an effective technique to produce shorter plants.

Plant spacing

Providing plants with more space allows the incoming radiation to benefit the plant canopy, thus reducing the far-red effect on stem elongation. Minimizing the number of rows of hanging baskets is critical to reducing the impact of far-red light on stem elongation of plants below.

Mechanical stress

Plants regularly brushed or vibrated a number of times per day will be shorter in height because of the internal generation of ethylene within the plant.

Cold water

Use of cold water applied overhead and trapped in the growing point can have a growth-regulating effect on some plants. For Easter lily (cv. Nellie White), research shows that plant height increases linearly with water temperature at a rate of approximately 1.5 cm/°C in the range of 2–20°C when 100 mL of water was applied two times a week within this temperature range. The water must be applied onto the meristem (apical point) of the plant rather than on the soil. Some bedding plants also respond positively to this technique, but plant form is critical because the cold water must be trapped within the growing point.

Plant Factors Influencing Plant Growth

During the last three decades, plant growth regulators (PGRs) have become an important cultural tool in modifying plant development in greenhouse flower crop production. They influence different plant processes, such as stem elongation, branching, rooting, flower induction and vegetative growth. This section focuses on factors to consider when limiting vegetative growth (controlling height) using PGRs.

Plant vigour

Provide PGRs only to vigorously growing plant species and/or vigorous cultivars. Rates that are effective on one cultivar may be too high or too low on another of the same species. Avoid using PGRs or use lower rates on less vigorous cultivars, as height reduction may be excessive. PGRs impose a stress on plants and healthy, vigorous plants are more likely to tolerate this stress. A dehydrated plant is more susceptible to phytotoxicity

from a PGR than a turgid plant. Apply PGRs only to plants with well-established root systems. For example, A-Rest applied to Easter lilies with poor root development can cause undue loss of bottom leaves.

Species and cultivar response

Not all species respond to all PGRs. The growth habit of a cultivar determines the PGR concentration and the number of applications required. For example, a vigorously growing potted chrysanthemum or verbena will generally need a higher concentration of PGRs than shorter or more compact cultivars. The same is true for most flowering plants including poinsettia, kalanchoe and geranium.

Stage of plant growth

PGRs are most predictable when applied to young plants. Improper timing may delay flowering or severely stunt plant growth. For example, Sumagic when applied at too high a rate will result in lilies with a palm tree effect or a section of weak stem, or when applied to poinsettia after the beginning of short days, bracts may be too small. Early application may affect the development of some (bottom) breaks on poinsettia and chrysanthemum. This effect is most pronounced with high rates of systemic PGRs.

Plant size

Plant size impacts PGR application. Smaller plants require lower rates or less chemical than larger plants. Bedding plant plug seedlings require lower rates and volumes compared with plants grown in flats or larger containers. Lower rates are usually used for young plants when the growing media is not covered with foliage, especially when the PGR has root uptake activity.

Environmental Factors Influencing Plant Growth

Plants grown under low temperature and light may require fewer PGR applications than those grown under higher light and temperatures. Adjust concentrations accordingly for winter and summer production, especially when using the more active or stronger PGRs such as Bonzi/Piccolo or Sumagic. Do not apply PGRs when temperatures exceed 26°C. If possible, apply during the evening or during periods of low transpiration losses so the plant tissue can absorb

the PGR. This is particularly true for contact PGRs such as B-Nine/Dazide and, to a lesser extent, Cycocel Extra. Bonzi/Piccolo and Sumagic are systemic PGRs that are quickly absorbed within the plant tissue.

Weather conditions directly influence absorption of the PGR following application and may affect results. Light and temperature conditions that favour rapid drying of spray droplets on foliage decrease the effectiveness of the water soluble PGRs, B-Nine/Dazide and Cycocel Extra, since less chemical is absorbed. Apply these products late in the day, during cloudy weather, and/or close the shading system when spraying to maximize chemical uptake. Avoid wetting the foliage of plants sprayed with B-Nine/Dazide and Cycocel Extra for at least 18 hours.

Use lower labelled rates and less volume per unit area during low light periods of the year when plant vigour is reduced. Two applications at a lower concentration applied 10–14 days apart usually results in better plant form or crop quality, than a single, higher concentration application.

Physical and Chemical Factors Influencing Plant Growth

Residual chemical effect

The length of time a PGR remains active in the plant after application varies. PGRs such as B-Nine/Dazide and Cycocel Extra lose most of their activity after 1–2 weeks. A-Rest, Bonzi/Piccolo, Sumagic, Florel, Configure and Fascination/Fresco remain active in the plant for at least 3–4 weeks, but duration is dependent upon environmental factors. Bonzi/Piccolo and Sumagic can remain active in the growing medium for a number of weeks.

Chemical uptake and translocation

Spray applications of Sumagic and Bonzi/Piccolo must be directed at the stems. Although these chemicals are readily absorbed by leaf tissue, they are not effective when applied only to the leaves because there is minimal movement from the leaf tissue to other parts of the plant.

B-Nine is slowly absorbed across the cuticle layer and has no systemic activity.

Configure has no systemic activity, so uniform application coverage is important.

Fascination/Fresco does not disperse well within the leaf, so uniform spray coverage is essential. Avoid runoff onto growing media because Fascination/Fresco moves into the plant through the roots, causing excessive stem elongation.

Florel is absorbed into the plant tissue, breaking down to form ethylene, which triggers a stress response within the plant including potential leaf yellowing and increased susceptibility to *Botrytis* and *Pythium* root rot.

Smaller spray droplet size improves coverage and increases the efficacy with less likelihood of phytotoxicity. If beading is observed, add a wetting agent to reduce the hydrophobic nature of many leaf surfaces,

With regard to drench and/or srench applications:

- Bonzi/Piccolo and Sumagic are actively taken up by roots and translocated to shoot tips, usually resulting in a less dramatic impact on growth when applied at low rates.
- A-Rest is readily absorbed and translocated from roots to the stems and leaves.
- Cycocel Extra is not readily absorbed by roots compared with Bonzi/Piccolo, Sumagic and A-Rest. Therefore the labelled rates to effectively control stem elongation are much higher. In Canada, Cycocel Extra is only registered as a media drench.
- It is important to remember that when applying PGRs by hand with a watering wand to drench, srench or as a coarse spray, the PGR is effectively being applied to the leaves, stems and growing media and may result in a greater growth-retarding effect.

Dosage and coverage

For most PGRs, the concentration of the active ingredient (a.i.) in the solution to be applied is critical. For simple conversion on a normalized level (1 or 1,000 ppm a.i.), see Table 9-1. *Dilution Guidelines for Plant Growth Regulators* on page 121.

Measure accurately using proper weighing instruments and/or measuring containers. For A-Rest, the rate for drenching is expressed as total active ingredient (a.i.)

per pot. This means that the solution concentration (mg/1000 mL or ppm) multiplied by the solution volume to be applied (mL/pot) should equal the dosage (mg/pot).

Coverage refers to the volume of solution sprayed per unit area, or for drenching, the volume of solution per pot size or area (if applied to soil beds).

Always read the label. There may be different formulations on the market or the formulation may have changed. Use the material according to the manufacturer's directions. The label may also indicate the need for a spreader/sticker.

Storage

Always store PGRs in a cool, dry, dark place. Do not allow temperatures to drop below 0°C. Shelf life is at least two years. Note that some PGRs may become unstable over time or less effective when mixed with high pH water. To prevent breakdown, mix just before using or acidify the water to a pH below 6.0.

Application method

Drench

Drench treatment is often more precise than spraying, but generally requires more labour unless applied through the irrigation system. Some PGRs (e.g., A-Rest, Bonzi/Piccolo and Sumagic) are systemic. They are actively taken up by roots and transported to the shoot tips. Cycocel Extra is only effective when drenched at high rates. Drenching may distribute the chemical more evenly within the plant and increase growth regulation. Drenches generally have less effect on flower size and flower delay and tend to provide longer control than sprays. Drenches can be applied more evenly than sprays because the volume per container is more easily measured. The drench volume is adjusted to reflect pot size. See Table 9-2. *Plant Growth Regulator Application Volumes* on page 121 for volumes based on pot size.

Drench applications of Sumagic and Bonzi/Piccolo are extremely effective, but accuracy is critical. Be sure roots are well-developed before drenching with any PGR. The growing media must be moist when making a drench application. Apply adequate amounts of solution to wet the entire root mass. Be sure plants are not stressed. Injury can occur if plants are even a little dry. Water the plants in late afternoon and apply the treatment the following morning. Another benefit of pre-watering is to have a more even distribution of the PGR throughout the substrate in the pot.

The only PGR registered for use through sub-irrigation is Piccolo. When applied through sub-irrigation, reduce rates by up to 50%. Do not reuse pots, trays or other containers that previously held plants or growing media treated with Sumagic and Bonzi/Piccolo. Be aware of possible residues remaining on flood tables, floors or troughs when these PGRs are used.

Pine bark-based mixes will reduce the effectiveness of A-Rest, Bonzi/Piccolo and Sumagic.

Spray

Spray application is often easier than a drench application, but ensuring uniform foliage coverage is critical. Spraying equipment must be operating properly, including sprayer pressure and distribution pattern of the nozzles or spray gun.

The volume applied per unit area varies depending on the age and size of the crop. The spray volume on the label reflects a typical crop with plants at different stages of development. The application approach will vary depending on the PGR.

Because Bonzi/Piccolo and Sumagic are absorbed primarily through plant stems, penetration of the plant canopy to get uniform coverage of the stems is important. They are very readily adsorbed to the growing media, making the active ingredient available for root uptake. It is important to avoid over-spraying.

Table 9-1. Dilution Guidelines for Plant Growth Regulators

Product Name	Active Ingredient	Formulation	Spray or Drench Solution	
			1 ppm	1,000 ppm
A-Rest	ancymidol	0.0264% (0.264 g/L)	3.8 mL/L	Not applicable for this product.
B-Nine WSG Dazide 85 WSG	daminozide daminozide	85 WSG (850 g/kg) 85 WSG (850 g/kg)	Not applicable for this product.	1.2 g/L 1.2 g/L
Configure	6-benzlaminopurine	21 g/L	0.0476 mL/L	47.6 mL/L
Bonzi Piccolo	paclobutrazol paclobutrazol	0.4% (4 g/L) 0.4% (4 g/L)	0.25 mL/L 0.25 mL/L	Not applicable for this product.
Cycocel Extra	chlormequat chloride	46.0% (460 g/L)	Not applicable for this product.	2.2 mL/L
Fascination/Fresco	benzyladenine + gibberellins A ₄ A ₇	1.8%/1.8% (W/W)	0.056 mL/L	Not applicable for this product.
Florel	ethephon	240 g/L	0.00416 mL/L	4.16 mL/L
Sumagic	uniconazole	0.055% (0.55 g/L)	1.8 mL/L	Not applicable for this product.

Most chemicals contain wetting agents. However, a spreader may be necessary to distribute the chemical uniformly on the foliage and lessen the likelihood of leaf damage. The beading of fine spray droplets on the leaf surface is a very good indication that additional wetting agent or surfactant is needed. Follow rates listed on the label for wetting agent being used. A rate of 10–20 L of spray solution/100 m² will generally give good coverage. For young and small plants, an even smaller volume should be used. To prevent chemical wastage, arrange the plants as closely together as possible without undue crowding.

Keep a separate sprayer for applying PGRs. Triple-rinse the sprayer after each application to prevent unnecessary damage to other crops from residues of previous PGR applications.

Use the application volumes in Table 9-2. *Plant Growth Regulator Application Volumes* on this page as a guide.

Table 9-2. Plant Growth Regulator Application Volumes

Pot Diameter (cm)	Volume of Solution (mL/ pot or plant)	
	Drench	Spray
10	90	3
13	120	6
15	180	10
20	240	17.5
25	300	25

When applied as foliar sprays, PGRs must be absorbed and/or transported within the plant. The active ingredient must move through the waxy cuticle layer of the leaf or stem and then into the plant tissue. Highly water-soluble PGRs such as B-Nine/Dazide, Cycocel Extra and Florel move slowly through the cuticle, while less soluble PGRs (Sumagic, Bonzi/Piccolo, A-Rest) penetrate very rapidly.

Plants should be turgid to prevent foliage damage. For B-Nine/Dazide, Cycocel Extra and Florel, absorption occurs while the foliage remains wet, which means they must be applied in the early morning, at the end of the day or under cloudy, humid conditions with lower air movement. For these products, avoid overhead watering for 12–24 hours to keep the foliage dry, so that the active ingredient is not washed off the plant.

A-Rest, Sumagic and Bonzi/Piccolo are absorbed very rapidly (within minutes), with little potential for being washed off after drying.

Number of applications

While a single drench or spray application may be the most economical, a single application treatment at the highest labelled rate often can lead to over-application, resulting in excessive plant growth regulation. Rate of application is very dependent on light, temperature, relative humidity, and watering and fertilization practices. A split application using the lowest label rate (usually half of the highest label rate) applied twice is a safer alternative in northern climates. A 1–2-week interval between applications increases flexibility and reduces the chance of plant damage. It also allows time to monitor plant growth, take weather changes into account, and make repeated applications accordingly. Plant shape generally improves when using the technique of multiple applications.

Estimating Final Plant Height

Floriculture researchers have found that the final height of chrysanthemum, Easter lily and poinsettia can be predicted using growth charts over time (graphical tracking). Graphical tracking can help determine more accurately the effectiveness of a growth retardant and in making informed decisions on the need for additional applications. Four weeks following the start of short days, typical chrysanthemum and poinsettia cultivars reach approximately half their final height at maturity. Easter lilies will approximately double in height from the time of visible bud. Measuring the plant height from the pot rim at this time and doubling this number provides an estimate of the final height. If the four-week estimated height is too tall, an additional PGR may be warranted. This will reduce growth further and produce a more desirable plant.

Growers should use graphical tracking in an integrated cultural program as a growth-monitoring technique. Graphical tracking programs are commercially available with typical growth curves for these crops.

Growth curves for each species are only a guide and will vary depending on variety vigour, tolerance to low light and other environmental conditions.

Directions for Mixing Plant Growth Regulators

Always read the label. Handle the chemicals according to the manufacturer's recommendations and observe all restrictions and precautions.

When mixing chemicals, note that the final volume of a PGR mixture should include the PGR that will be added. First measure the chemical, then add about half of the required water to the tank followed by the measured chemical, followed by more water until the desired final volume of the solution is reached. For example, if the label directions read 60 mL B-Nine/Dazide per L, first add 0.5 L of water, then add 60 mL of B-Nine/Dazide to a suitable measuring container, before adding more water to the 1 L mark. Remember that the final solution, including the B-Nine, should be 1 L. Agitate well before and during spraying.

In general, do not add wetting agent (spreader/non-ionic surfactant) if the label states that this is already present in the solution. However, if excessive beading occurs, add wetting agent or surfactant to eliminate the beading.

Read the label to see if the material is sufficiently stable for storage after mixing. It is best to mix PGR products right before each application to ensure proper chemical activity.

Do not mix PGRs with other pesticides. Growth regulator applications are too critical. Do not take chances to save time. Mix and apply PGRs precisely.

Use Pattern of Growth Regulators on Greenhouse Ornamentals

The effectiveness of PGRs can be very crop-dependent. Read the label before applying any PGR. See Table 9-3. *Summary of PGRs by Crop* on this page, and Table 9-4. *Plant Growth Regulators*, on page 124.

Table 9-3. Summary of PGRs by Crop

Crop	Registered PGRs
All cut flower, flowering potted and foliage crops	EthylBloc Technology
Azalea	B-Nine/Dazide
Bedding plants	B-Nine/Dazide, Bonzi/Piccolo, Florel, Sumagic
Chrysanthemum (pot)	A-Rest, B-Nine/Dazide, Florel, Sumagic
Chrysanthemum (garden)	A-Rest, B-Nine/Dazide, Florel Sumagic
Chrysanthemum (cut)	B-Nine/Dazide
Echinacea spp. (purple coneflower)	Configure
Geranium (zonal)	Bonzi/Piccolo, Cycocel Extra, Florel, Sumagic
Holiday Cactus (Schlumbergera spp. and Rhipsalidopsis spp.)	Configure
Hosta spp.	Configure
Hydrangea	B-Nine/Dazide
Easter lily	A-Rest, Fascination/Fresco, Sumagic
Lily – Asiatic, Oriental and Asiflorum hybrids	A-Rest, Fascination/Fresco
Poinsettia	A-Rest, B-Nine/Dazide, Cycocel Extra, Florel, Sumagic

Table 9-4. Plant Growth Regulators

A-Rest (264 mg/L or 0.0264% ancymidol)	
Crops	Chrysanthemum (potted), lily, poinsettia.
Concentration of active ingredient	2–8 ppm
Mixing rate	2 ppm = 7.5 mL per L final solution 8 ppm = 30 mL per L final solution
Method of application	Drench. Apply 0.25–0.50 mg active ingredient per 15 cm pot.
Timing	Chrysanthemum: Apply just as root system spreads over outside of root ball, or approximately 2 weeks after pinch when laterals are 5–10 cm long. Lily: Apply when lily is 7–15 cm tall. Do not apply between Jan. 23 and Feb. 7, as bud count may be reduced. Poinsettia: Treat plants from pinch to 4 weeks after pinch, or 8–12 weeks before finish. Do not apply after bract initiation has begun.
Comments	Entire soil surface must receive uniform application. Do not apply a wetting agent. Ensure healthy roots and adequate phosphorus nutrition of Easter lily to minimize lower leaf yellowing.

Cycocel Extra (46.0% or 460 g/L chlormequat chloride)	
Crops	Geranium (zonal), poinsettia.
Concentration of active ingredient	Geranium: 1,500–3,000 ppm Poinsettia: 1,500–3,000 ppm
Mixing rate	1,500 ppm = 3.25 mL per L (325 mL/100 L) final solution 3,000 ppm = 6.5 mL per L (650 mL/100L) final solution
Method of application	Drench.
Timing	Geranium (zonal): Apply as a drench at 1,500–3,000 ppm 3 weeks after transplanting, when well-rooted and stem begins to elongate. Poinsettia: Apply when lateral shoots are 2–4 cm tall.
Comments	Geranium (zonal): Application induces earlier flowering and promotes branching. Poinsettia: Application later than Oct. 15 for poinsettias, grown under natural photoperiod, may delay flower development and reduce bract size. Drenching twice with half the label rate results in better plant quality than once at the high concentration.

B-Nine WSG/Dazide 85 WSG (85% daminozide)	
Crops	Azalea, bedding plants (petunia, marigold, zinnia, aster, cosmos and salvia), chrysanthemum (potted and cut), hydrangea, poinsettia.
Concentration of active ingredient	Azalea: 1,500–2,500 ppm Bedding plants: 5,000 ppm Chrysanthemum <i>pots</i> : 2,500–5,000 ppm <i>cuts</i> : 2,500 ppm Hydrangea: 5,000 ppm Poinsettia: 5,000–7,500 ppm
Mixing rate	1,500 ppm = 1.8 g/L final solution 2,500 ppm = 3.0 g/L final solution 5,000 ppm = 6.0 g/L final solution
Method of application	Spray 2–4 L/100 m ² of bench area. A crop with larger leaf area will require more volume to be applied per unit of bench area. Spray to runoff.

B-Nine WSG/Dazide 85 WSG (85% daminozide)	
Timing	<p>Azalea: Apply after last pinch when shoots are 2–5 cm long to promote development of additional buds on plants grown for forcing. Make 1 application at 2,500 ppm or 2 applications at 1,500 ppm, 1 week apart.</p> <p>Bedding plants: Apply to point of runoff 2–3 weeks after transplanting or when the plant shoots begin to elongate. Repeat as required.</p> <p>Chrysanthemum (pots): Apply to runoff about 2 weeks after pinching when shoots are 2–4 cm long. May be repeated 3 weeks later.</p> <p>(Pots & cuts): To prevent stretching of the peduncles, spray 2 days after disbudding or 4 weeks after shade initiation. Spray only the top 1/3 of the foliage to runoff.</p> <p>Hydrangea: Apply first spray 2–3 weeks after beginning to force (4–5 leaf pairs visible), second spray 2–4 weeks later.</p> <p>Poinsettia: Spray when shoots are approximately 5–7.5 cm tall. Spray concentration depends on planting and pinching date (which depends on pot size). Vigorous plants may need a second application. Do not apply after September 15.</p>
Comments	<p>Azalea: Application increases short-day response and early bud formation. Do not let solution drip onto growing medium.</p> <p>Bedding plants: As a PGR it is effective on most bedding plants but ineffective on snapdragon, celosia, coleus, pansy, geranium, carnation, cleome, convolvulus and gomphrena.</p> <p>Chrysanthemum (pots): Use low concentration on pinched crops, high concentration on single-stem plants. Spray foliage to run off; (Cuts): Do not mix daminozide with other pesticides.</p> <p>Hydrangea: Apply after buds are visible if necessary.</p> <p>Poinsettia: Do not add any wetting agent. Application made after initiation of short days will delay blooming and impact bract size.</p> <p>Do not wet foliage for 18–24 hours following application to allow absorption into the plant.</p>

Bonzi/Piccolo (4 g/L paclobutrazol)	
Crops	Container-grown ornamental bedding plants in plug trays, cell packs, flats or pots.
Concentration of active ingredient	0.5–60 ppm depending on method of application (drench or spray) and crop species. <i>Read the label carefully. Paclobutrazol is extremely active at very low concentrations. Test with lower concentrations on all species and cultivars.</i>
Mixing rate	<p>1 ppm = 0.25 mL per L final solution</p> <p>2 ppm = 0.5 mL per L final solution</p> <p>10 ppm = 2.5 mL per L final solution</p>
Method of application	<p>Spray using 1–40 ppm depending on species applying 1–2 L per 10 m² of bench area for small plants in plug trays depending on the stage of plant growth.</p> <p>For plants with well-developed canopy, 3 L/10 m² may be required.</p> <p>Drench using: 0.5–1.0 ppm applying 60–80 mL per 10 cm pot; 120–140 mL per 15 cm pot.</p>
Timing	For bedding plant plug seedlings, make first spray application at the first- or second-leaf stage. Apply to plants in cell packs or pots once plants are established after transplanting, usually 2–3 weeks later. Apply when flower stems begin to elongate to reduce late stretch of peduncles.
Comments	<p>Bonzi/Piccolo spray applications are absorbed through the stems, so thorough and uniform coverage is essential. Over-application, especially with spray applications, will result in stunting and delayed flowering.</p> <p>Desired height control is usually obtained with a single spray or drench application, but better height control can also be obtained by multiple applications at 25–50% of the label rate, particularly under lower light and temperature conditions.</p> <p>High spray rates may delay flowering of impatiens and petunia.</p> <p>Take care not to apply excessive amounts of spray to young plants that have not completely covered the medium; excess may enter the medium and act as a drench, resulting in excessive stunting of sensitive species.</p> <p>Drench applications tend to be most effective in controlling plant height and producing a uniform effect. Application can be made near marketable size without phytotoxic effect.</p> <p>Apply only to moist growing media. Media containing bark may require higher application rates. Do not reuse pots or trays that had plants or soil treated with Bonzi/Piccolo.</p> <p>When applying Piccolo through sub-irrigation, reduce rates by 25–50%.</p>

Configure (21g/L 6-benzylaminopurine)	
Crops	Holiday cactus (<i>Schlumbergera</i> spp., <i>Rhipsalidopsis</i> spp.), <i>Hosta</i> spp., <i>Echinacea purpurea</i> (purple coneflower)
Concentration of active ingredient	100–3,000 ppm depending on use pattern and crop species. Test with small groups of plants first using the lowest label rate as response can vary with cultivars and adjust accordingly.
Mixing rate	100 ppm = 4.76 mL per L final solution 1,000 ppm = 47.6 mL per L final solution 3,000 ppm = 142.8 mL per L final solution
Method of application	Holiday cactus: <ul style="list-style-type: none"> • Foliar spray at 100 ppm after planting when new vegetative growth begins. • Foliar spray at 100–200 ppm after the start of short days following levelling. <i>Hosta</i> spp.: <ul style="list-style-type: none"> • Foliar spray at 1000 - 3000 ppm when plants are fully established in the pot. <i>Echinacea</i> (Purple Coneflower): <ul style="list-style-type: none"> • Foliar spray at 300–900 ppm approximately 2–3 weeks after transplanting.
Timing	Holiday cactus: <ul style="list-style-type: none"> • To increase branching under vegetative conditions: 100 ppm after planting when new vegetative growth begins. • To increase floral initiation: apply 5–10 days after the start of short days or immediately after levelling. <i>Hosta</i> : <ul style="list-style-type: none"> • Apply 1–2 times once plants are fully established, usually 3-4 weeks after planting. <i>Echinacea</i> (Purple Coneflower): <ul style="list-style-type: none"> • Apply as a single foliar spray once active growth is present.
Comments	Configure sprayed on Holiday cactus will promote vegetative branching when applied during long days. Application at too high a concentration may cause phylloclade distortion. Configure will promote the number of flower buds under short days (reproductive conditions). Application at too high a rate will cause initiation of too many flower buds per mature phylloclade. Configure will increase lateral growth when applied to <i>Hosta</i> or <i>Echinacea</i> being grown on for retail sales.

Fascination/Fresco (1.8% benzyladenine, BA, and 1.8% gibberellins, GA₄₊₇)	
Crops	Easter lily, Asiatic hybrid lily, Oriental hybrid lily and <i>Asiflorum</i> hybrid lily.
Concentration of active ingredient	25–100 ppm of benzyladenine and GA ₄₊₇
Mixing rate	25 ppm = 1.4 mL per L final solution 100 ppm = 5.6 mL per L final solution

Fascination/Fresco (1.8% benzyladenine, BA, and 1.8% gibberellins, GA₄₊₇)

Method of application	Easter Lily: Direct spray at 25–100 ppm to the lower 1/3 of the foliage at visible bud stage, to prevent leaf yellowing. Asiatic, Oriental, Asiflorum hybrid lilies: Apply to entire plant at 50–100 ppm at visible bud stage and one day before being placed in cold storage to delay leaf yellowing and flower senescence following cold storage. Use standard equipment at low pressure to avoid misting the immature leaves and stem, which will cause stretching of plants. Apply 1.9 L of spray solution to 10 m ² of bench area; ensure proper coverage of lower leaves but no more than 15 mL per plant, as soil application can also cause stretch. The product is not systemic so only leaves and leaf surfaces contacted will be protected from leaf yellowing.
Timing	Apply at visible bud stage or just prior to cold storage.
Comments	Differences in plant response due to differences in plant surfaces, leaf orientation and plant structure are possible. Apply during morning or late afternoon, when plants are not under stress. Avoid direct contact to immature leaves as it will result in unwanted stem elongation.

Florel (240 g/L ethephon)

Crops	Greenhouse ornamentals including New Guinea impatiens, begonia, chrysanthemum (garden types), fuchsia, geranium, sweet potato vine (Ipomea) lantana, poinsettia, verbena and vinca vines.
Concentration of active ingredient	250 ppm = 1.04 mL/L final solution 500 ppm = 2.08 mL/L final solution
Method of application	New Guinea Impatiens: 250 ppm applied uniformly as a spray to foliage to glisten but not to runoff. Other greenhouse ornamentals: 250–500 ppm applied as foliar spray to glisten but not to runoff. Ensure the pH of spray solution is maintained at 5.5 to maintain effectiveness.
Timing	Stock plants: Apply to stock plants on a 14-day interval with a maximum of 4 applications. Finished plants: Apply beginning 14–21 days after transplanting and re-apply every 10–14 days if necessary to a maximum of 4 applications. Apply in evening or early morning and ensure warm temperatures.
Comments	Florel increases lateral branching, reduces leaf size and stem elongation and will trigger senescence of immature flower buds. For flowering bedding plants do not apply 6–8 weeks prior to planned date of flowering or sale. Do not apply when plants are under stress from drought, high temperature, or disease as Florel breaks down to ethylene when it enters the plant triggering a stress response. Use low rate under low light conditions and on compact varieties to prevent excessive growth regulating effects. The activity of Florel is linked to plant growth activity and so is slower when temperatures are below 15°C and very high when above 35°C. Do not apply more than 1 L of solution/10m ² of bench space. Do not apply within 2 weeks of harvesting cuttings from stock plants.

Sumagic (0.055% uniconazole-P)

Crops	Bedding plants, chrysanthemum, Easter lily, geranium (seed and zonal), poinsettia.
Concentration of active ingredient	Bedding plants: 1–30 ppm Chrysanthemum: 5–10 ppm Easter lily: 3–30 ppm Geranium: 2–4 ppm (seed); 2–8 ppm (zonal and ivy) Poinsettia: 2–8 ppm
Mixing rate	1 ppm = 1.8 mL per L final solution 2 ppm = 3.6 mL per L final solution 10 ppm = 18 mL per L final solution
Method of application	Spray (use 1–2 L per 10 m ² of bench area depending on the stage of plant growth). Low pressure and larger droplet size will provide best results.

Sumagic (0.055% uniconazole-P)	
Timing	<p>Bedding plants: Timing varies depending on the species being treated. Read the label carefully. First application is usually made when seedlings are 2.5–3.0 cm tall.</p> <p>Chrysanthemum: Apply 7–14 days after pinch when the length of the breaks is 3.8–5.0 cm. A single repeat spray can be made 7–21 days after the first, to increase the level of growth reduction.</p> <p>Easter lily: Apply when shoots are 7.5 cm tall. Do not make repeated applications within 2 weeks and avoid late applications.</p> <p>Geranium: (seed) Apply when plant height is 5–16 cm; (zonal) Apply to cuttings once rooting is established.</p> <p>Poinsettia: Apply when breaks are 3.5–5.0 cm long (about 10–14 days after pinching). Up to two repeat applications can be made at 7-day intervals until desired growth characteristics are achieved. Do not apply once the initiation of bracts has begun.</p>
Comments	<p>Plant response to Sumagic is strongly influenced by cultural and environmental factors such as growing media, water/fertilizer management, temperature, light, greenhouse structure and other cultural practices. Treat a limited number of plants at the lowest label rate when using for the first time. Lower rates may be needed at lower temperatures.</p> <p>Bedding plants: Use the lowest label rate. Check response of each species and cultivar first on a small group of plants as per label directions.</p> <p>Chrysanthemum: Two applications will have a better horticultural effect than the same amount of product applied as a single treatment.</p> <p>Easter lily: Treatment with Sumagic may reduce the water requirement of Easter lily. Avoid late-season applications. Under Ontario conditions, the rate of 2–3 ppm seems suitable with a maximum of three sprays per season.</p> <p>Poinsettia: Bract size and overall inflorescence diameter may be slightly reduced with treatment, and days to flowering will be delayed if applied after the initiation of short days.</p>

EthylBloc Technology (0.14% 1-methylcyclopropene)	
Crops	Registered for use on cut flowers, potted flowers and foliage plants as a postharvest treatment to protect against the effects of ethylene.
Concentration of active ingredient	Apply 0.25 or 0.5 g/m ³ depending on treatment time and storage temperature. Read label carefully when selecting rate of application.
Method of application	Place EthylBloc Technology water-soluble packets (based on volume of treatment room) in water to dissolve and begin the release of the 1-MCP vapour (gas) within tightly closed storage rooms or containers under both refrigerated and room temperatures.
Timing	Make single application immediately after harvest or just prior to shipping of cut flowers, flowering potted plants and foliage plants.
Comments	<p>Treatment period is dependent on storage temperature; minimum of 4 hours is required when done at 10–24°C and 8 hours when done between 2–10°C.</p> <p>Treatment rooms must be posted, vents closed but with good internal air circulation and vented for 30 minutes prior to re-entry.</p>