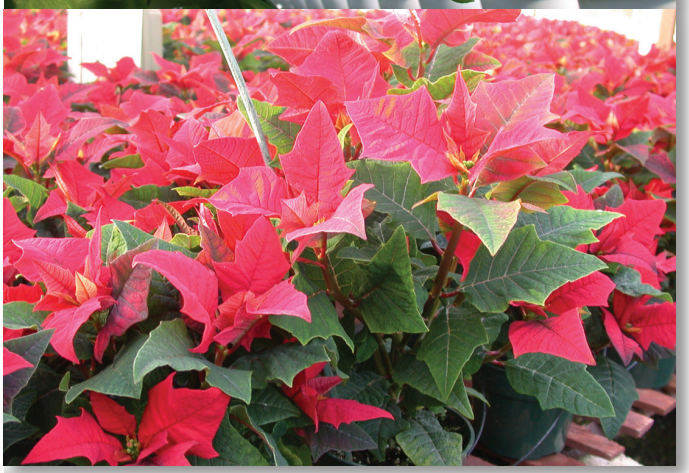
Selecting and Using Plant Growth Regulators on Floricultural Crops



Virginia Cooperative Extension

VirginiaTech
Invent the Future

VSU
Virginia State

NC State University
A&T State University
Cooperative Extension
Empowering People · Providing Solutions

Selecting and Using Plant Growth Regulators on Floricultural Crops

Joyce Latimer, Extension Specialist, Greenhouse Crops, Virginia Tech

Brian Whipker, Extension Specialist, Floriculture Crops, North Carolina State University

Optimizing Results

Plant growth regulators (PGRs) are chemicals that are designed to affect plant growth and/or development (figure 1). They are applied for specific purposes to elicit specific plant responses. Although there is much scientific information on using PGRs in the greenhouse, it is not an exact science. Achieving the best results with PGRs is a combination of art and science — science tempered with a lot of trial and error and a good understanding of plant growth and development.

Figure 1. With warm growing conditions, this petunia plant is beginning to grow excessively. A plant growth regulator is needed to manage growth.

For best results, PGRs should be handled as production tools — like water and fertilizer. PGRs should be an integrated part of your crop production cycle. They should not be used as crutches for poor management of other cultural practices. However, PGRs should be used in conjunction with a number of nonchemical control options to manipulate plant growth so well-proportioned, compact plants are produced.

Biological Control

Selecting shorter growing cultivars is often the first step available to growers for reducing the occurrence of overgrown plants. While this works well in theory, it may not be commercially practical. Customer demand for specific color or growth-form characteristics may limit your choices. However, response to PGRs depends on species and cultivar selection. In general, slow-growing or dwarf cultivars will require less PGR than more vigorous cultivars. Some plant species or cultivars are responsive to specific PGRs, but not all PGRs. Research your crop, including its responsiveness to PGRs.

Environmental and Cultural Control

Knowing how the growing environment and cultural practices can affect plant growth will help in managing a crop's growth. There are a number of factors that can be manipulated in the greenhouse or nursery to reduce plant growth: container size, timing of transplant or seeding, irrigation practices, nutrient management, mechanical conditioning, light quality and quantity, pinching, and temperature. How these factors are manipulated will affect whether chemical control is necessary, and if so, the amount of PGR required for optimum growth control.

Container Size

Root restriction can be used to control plant growth by utilizing a small container or by increasing the number of plants per pot. This method works especially well when other production parameters, such as ample light, wide spacing, and proper nutrition are provided. Plants grown in small pots at close spacing will require more chemical growth regulation for adequate growth control than those receiving ample light.

Timing

One of the most effective methods of controlling excessive plant growth is by crop timing. The simple method of staggering the finish time of a crop at two- to three-week intervals is very effective with many crops, like bedding plants. This ensures that a new supply of plants will be available, which avoids the need to hold a crop beyond its market window, when it generally becomes "leggy."

Irrigation Practices

A traditional method of controlling plant growth is to withhold water. Drought stress can be used on a number of crops, including impatiens and tomatoes. Allow the plants to wilt slightly between irrigations, but do not allow them to reach the permanent wilting point. Drought stress will lead to shorter plants, but excessive stress or drought stress of sensitive crops may have the undesirable effects of reduced plant quality and delayed flowering. Drought stress may also cause premature bolting of some crops, such as ornamental cabbage and kale (cole crops).

Growers who tend to "run their plants dry" will use less PGRs than growers who run their plants wet. The method of irrigation can affect the plants' response to

PGRs. Plants grown on subirrigation trays or water collectors should be treated with lower rates of soil-active PGRs because the overspray from the treatment will be available to the roots during subsequent irrigation events.

Nutrient Management

Reducing or withholding fertilizer tends to slow overall plant growth. Limiting the amount of nitrogen to 50 to 100 parts per million (ppm) will help control the growth of many crops, such as bedding plants. The type of nitrogen supplied can also impact plant growth. Relying on nitrate-nitrogen instead of ammoniacal-nitrogen or urea-nitrogen forms — which encourage lush growth — will also help.

Phosphorus is the primary element that promotes stem elongation. Plug producers commonly use low-phosphorus fertilizers like 13-2-13 Cal-Mag or 15-0-15, which does not contain phosphorus to help limit stem elongation. As with "dry" plants, nutrient-deficient plants require less growth regulator for growth control than lush plants.

Mechanical Conditioning

Brushing plants is a very effective way of controlling plant height (30 percent to 50 percent reductions) of many vegetable transplants or herbs. Currently, only one PGR (Sumagic, Valent USA) is labeled for chemical growth control of fruiting vegetable transplants.

Brushing involves the movement of a PVC pipe, wooden dowel rod, or burlap bags over the top third of the plant. Research at the University of Georgia suggests that plants should be brushed daily for about 40 strokes to obtain the greatest effect. The foliage should be dry to avoid damage to the leaves. This method is not effective on plants such as cabbage or broccoli. It should not be used if foliar diseases or, in many cases, flowers are present. Evaluate the degree of growth regulation provided by brushing before adding a PGR treatment. Also, be aware that the effects of brushing on plant growth dissipate within three to four days after you stop applying the treatment. So, you may want to apply a low rate of a PGR to provide continued growth control during the shipping, handling, and retail phases.

Pinching

Pinching can be used to improve the shape of the plant, increase branching, and control excessive stretch. However, the labor costs of pinching and the subsequent delay in plant development may not make it an economically feasible option of controlling growth of many crops (figure 2).

Figure 2. Trimming plants is an effective method of controlling growth. Labor for trimming and the added production time need to be considered when determining the true cost of mechanical pinching.

Light Quality and Quantity

Higher light quality tends to limit plant elongation, resulting in shorter plants. Low light quality caused by late spacing or crowding of the crop or too many hanging baskets overhead can lead to leggy plants and should be avoided.

Photoperiod also can be used to control the growth of many plants. This practice is widely used with pot chrysanthemums by providing taller cultivars with only one week of long days (LD) to limit vegetative growth when compared to shorter cultivars, which receive three weeks of LD to promote growth.

Light quantity also affects plant growth. Higher light levels improve plant growth and quality, as well as branching. Spacing will often determine the need for and amount of additional chemical control necessary for optimum height control under high light levels.

Temperatures

Temperature manipulation can be used very effectively to control plant growth. Lower temperatures slow plant growth. Remember to account for the effects of lower temperatures on the developmental processes of the plant, i.e., lower temperatures may delay flowering, so you may need to adjust your crop schedules to hit your market window.

Lower rates of PGRs are required for plants grown under lower temperatures. Conversely, higher

temperatures enhance plant growth and higher rates of PGRs are necessary for adequate growth regulation.

Some growers use differential day/night temperatures (DIF) to control growth. In the South and Mid-Atlantic regions, we are typically limited to a DIP in temperatures, where we reduce the predawn temperatures to 5 to 10 degrees Fahrenheit (F) lower than the night temperature setting and hold it for up to four hours. This treatment reduces growth at the time of day that cell elongation is greatest and therefore controls plant height. Obviously, do not drop the temperature low enough to injure cold-sensitive crops.

Optimizing plant growth control requires an understanding of the effects of environmental and cultural conditions on plant growth. Experience and in-greenhouse trials will allow you to combine PGRs with a number of nonchemical control options to manipulate plant growth to produce high-quality, compact plants.

Choosing the Correct PGR

The selection of PGRs and their application rates will be affected by the vigor of the cultivars selected and how your crop is grown. Especially with very vigorous plants, higher fertility and irrigation levels will increase the amounts of growth regulator required to prevent excessive growth. Shading, lower light levels, or tight plant spacing — especially under higher growing temperatures — will also increase plant stretch and reduce lateral branching. For the highest-quality plants, the use of PGRs must be integrated into your production plan.

PGRs are most effective when applied at the appropriate times to regulate plant growth or development. In other words, growth retardants cannot "shrink" an overgrown plant. They must be applied before the plant is overgrown to avoid plant stretch. When planning PGRs in your production schedule, consider what you want to accomplish with the treatment.

- Do you want to **regulate shoot growth** of the plant, resulting in a sturdier, more compact plant with improved color? If so, you probably want a **growth retardant**.

- Do you want to **increase plant branching** for enhanced cutting production or for a bushier potted plant or hanging basket? If so, you probably want to use a **branching agent** or "chemical pincher."

- Do you want to **enhance flower initiation** or synchronize flowering? If so, you probably want to use **chlormequat chloride** or **gibberellic acid**.

- Do you want to **remove flowers** from stock plants to increase the number of vegetative cuttings? If so, you probably want to use an **ethylene-generating compound**.

Answering these questions will indicate which type of PGR you need to use to accomplish your goal and the most appropriate timing of the application. Then you will need to select a specific PGR in that class and determine the appropriate dosage and application method to attain the desired response.

Regulating Shoot Growth

Most PGRs used in the greenhouse or nursery are used to regulate shoot growth of containerized crops. These PGRs are referred to as "growth retardants." Typical growth retardants are ancymidol (Abide or A-Rest), daminozide (B-Nine or Dazide), chlormequat chloride (Citadel or Cycocel), flurprimidol (Topflor), paclobutrazol (Bonzi, Downsize, Paczol, Piccolo, or Piccolo 10 XC), and uniconazole (Concise or Sumagic).

Now that most of the PGR chemistries are off-patent, there are several options available (table 1). These PGRs control plant height by inhibiting the production of gibberellins, the primary plant hormones responsible for cell elongation. Therefore, these growth-retardant effects are primarily seen in stem, petiole, and flower stalk tissues. Lesser effects are seen in reductions of leaf expansion, resulting in thicker leaves with a darker green color (figure 3).

Figure 3. The use of plant growth regulators typically results in a darker green leaf color, such as the plant on the right.

Table 1. Plant growth regulators used to reduce plant height during the production of floricultural crops.

Common name Trade name	**Application methods**	**Comments**	**Concerns**
Ancymidol **Abide** (Fine Americas Inc.) **A-Rest** (SePRO Corp.)	Foliar spray Bulb dip Drench Chemigation Injection	Broad-spectrum label. Very safe. Very active on many bedding plants (except geraniums and impatiens); commonly used on plugs. **Abide** label prohibits spray applications in shadehouses or nurseries. Drench applications can be made indoors or outdoors. **A-Rest** labeled for use as spray or drench on containerized ornamentals grown in nurseries, greenhouses, shadehouses, and interiorscapes.	Relatively expensive for many crops but used extensively on plugs. Maximum spray rate is 132 ppm*. Do not add wetting agent. Follow all label directions for all chemigation uses. Do not reuse pots, trays, or media previously treated with ancymidol.
Daminozide **B-Nine 85WSG** (OHP Inc.) **Dazide 85WSG** (Fine Americas Inc.)	Foliar spray Cutting dip	Apply uniformly to all foliage. No soil activity. Effective on a broad list of species, but low-level activity and short residual; multiple applications generally required. Increased activity when tank-mixed with chlormequat chloride. Labeled for use on beds and containers in greenhouses, shadehouses, and nurseries. Limited to containerized plants in uncovered production areas.	Safe, with few incidences of phytotoxicity or overstunting. Do not overhead irrigate within 24 hours after treatment. Do not tank-mix daminozide with compounds containing copper or apply daminozide within 7 days of such treatments.
Chlormequat chloride **Citadel** (Fine Americas Inc.) **Cycocel** (OHP Inc.)	Foliar spray Drench	Standard for geraniums, poinsettias, and hibiscus; enhances flowering of geranium and hibiscus. Label allows use on a broad spectrum of crops in the greenhouse. Activity is low; multiple applications generally required. Increased activity when tank-mixed with daminozide. Only **Cycocel** is labeled for use as a spray on containerized plants in the outdoor nursery (maximum 3,000 ppm, three times in any crop production cycle).	Causes discoloration of leaves, especially with rates above 1,500 ppm; phytotoxicity reduced in tank mix with daminozide. Less effective under high temperature conditions.
Flurprimidol **Topflor** (SePRO Corp.)	Spray Drench Chemigation Subirrigation	Labeled for use as spray or drench on containerized ornamental plants grown in nurseries, greenhouses, and shadehouses (greenhouses only in New York).	Do not use on plugs of begonia, pansy, salvia, or vinca. Do not use wetting agents. Do not reuse pots, trays, or media previously treated with flurprimidol.

* ppm = parts per million

Table 1. Plant growth regulators used to reduce plant height during the production of floricultural crops. (cont.)

Common name Trade name	**Application methods**	**Comments**	**Concerns**
Paclobutrazol **Bonzi** (Syngenta Crop Protection) **Downsize** (Greenleaf Chemical LLC) **Paczol** (OHP Inc.) **Piccolo** and **Piccolo 10 XC** (Fine Americas Inc.)	Spray Media spray (Paczol only) Drench Bulb dip Liner dip (Paczol, Piccolo only) Chemigation Subirrigation	Labeled for use as spray or drench on containerized ornamental plants grown in nurseries, greenhouses, shadehouses, and interiorscapes. Apply uniformly to cover stems (not absorbed by leaves). Much more active than above PGRs; measure accurately. Spray procedure and uniformity greatly affects results. **Piccolo** and **Piccolo 10 XC** sprays are limited to enclosed areas (greenhouses) to eliminate drift. Very soil-active as a drench. **Piccolo** is also available as a 10x clear concentrate (**Piccolo 10 XC**, 4% a.i.) that requires less agitation to stay in solution. **Downsize** is labeled only for drench applications indoors or outdoors, manually or through chemigation.	Spray volume critical to establishing rates due to drench effect of runoff. Use higher rates under high temperature conditions. Late spray applications can reduce flowering. Phytotoxicity includes overstunting and may cause black spots on annual vinca (*Catharanthus roseus*). Avoid drift onto nontarget plants. Agitate spray solution often for uniform concentration. Do not reuse pots, trays, or media previously treated with paclobutrazol.
Uniconazole **Concise** (Fine Americas Inc.) **Sumagic** (Valent USA Corp.)	Spray Media spray Drench Bulb dip Liner dip (mums)	Labeled for use as spray or drench on containerized ornamental plants grown in greenhouses, lath houses, and shadehouses. Not labeled for chemigation. **Sumagic** is also labeled for greenhouse-grown fruiting vegetable transplants (see Supplemental Label). Apply uniformly to cover stems (not absorbed by leaves). Spray procedure and uniformity greatly affects results. Very soil-active as a drench.	Spray volume critical to establishing rates due to drench effect of runoff. Use higher rates under high temperature conditions. Do not add wetting agents. Late applications can reduce flowering. Phytotoxicity includes overstunting. Avoid drift onto nontarget plants. High leaching potential. Do not apply to pots on dirt floors. Do not reuse pots, trays, or media previously treated with uniconazole.

* ppm = parts per million

Other benefits of using these PGRs in plant production include improved plant appearance by maintaining plant size and shape in proportion with the pot and increased shipping capacity with the smaller plants. Plant growth retardants also increase the tolerance of plants to the stresses of shipping and handling, as well as retail marketing, thereby improving shelf life and extending plant marketability.

Remember, growth retardants do not reduce plant size. They limit the plant's growth rate. You must apply the growth retardant prior to the "stretch." Look for recommendations on the PGR label for time of application. These recommendations will be given in terms of plant development or plant size, as opposed to production time.

For example, uniconazole (Concise or Sumagic) labels specify that pansies should have attained a minimum height of 4 inches prior to application. Paclobutrazol (Bonzi, Paczol, Piccolo, or Piccolo 10 XC) labels state that bedding plant plugs should be treated at the one to two true-leaf stage and bedding plants (after transplanting) at 2 inches of new growth or when the plants reach marketable size.

Generally, growth-retarding PGRs should be applied just prior to rapid shoot growth. This is generally one to two weeks after transplanting a plug, after the roots are established, and as the plant resumes active growth. On pinched plants, it is after the new shoots are visible and starting to elongate.

This is where the art of plant growth regulation is most important. You must learn how your crop grows and when to intervene to obtain the desired results. Remember to note details of crop development in your records of PGR treatments. For example, due to weather conditions, next year you may need to treat at seven days after transplanting instead of at 10 days after transplanting, which you used this year. You must gauge when rapid elongation will likely occur and treat to counter it.

Many growers use multiple applications of growth retardants to better control plant growth. A single application at a high rate early in the plant production cycle may be excessive if growing conditions are not as good as expected. An early application at a lower rate provides more flexibility, but the tradeoff is the additional labor involved with a second application if it becomes necessary. Some growers improve crop uniformity by using multiple applications of lower rates to affect small corrections in plant growth.

Be aware that excessive rates of many of these PGRs can cause persistent growth control in the flat or even in the landscape. It is always a good idea to evaluate the long-term effects of your treatments by growing some out for yourself and talking with your customers.

Be careful to avoid late applications, especially of paclobutrazol or uniconazole, because they may delay flower opening on bedding plants. However, drench applications of paclobutrazol have provided excellent control of poinsettia height very late in the production cycle without causing the reduction in bract size accompanying late spray applications. Learn the art of using PGRs for plant growth regulation.

Ancymidol (Abide or A-Rest; Restricted-entry interval [REI] = 12 hours) is a more active compound than daminozide or chlormequat chloride. Ancymidol is active as a spray or a drench, so application volume affects plant response. In addition, ancymidol is labeled for chemigation, i.e., distribution through the irrigation system via flood, sprinkler, or drip systems. Follow all label directions. Abide is not labeled for spray applications in shadehouses or nurseries, but drench applications can be made indoors and outdoors. A-Rest is labeled for use as a spray or drench on containerized plants in greenhouses, nurseries, shadehouses, and interiorscapes.

Ancymidol is widely used as a foliar spray for treatment of plants in the plug stage. Its relatively high activity and toning ability produces excellent plugs. Many growers consider ancymidol to be the product of choice for pansy production. Rates vary with cultivar or series. For example, the Delta series is more responsive to PGRs than the Sky/Skyline series.

Daminozide (B-Nine or Dazide; REI = 24 hours) was one of the first PGRs labeled for use in the floriculture industry and is still widely used. In general, it is not phytotoxic and has a short-term effect that seldom results in overstunting of treated plants. The low activity of daminozide and its lack of soil activity make it easier to get consistent, predictable responses than with the newer, more potent PGR chemistries. Plants should be well-irrigated prior to treatment, but foliage should be dry at the time of treatment. Do not irrigate overhead for 18 to 24 hours after treatment.

The low activity also means that daminozide must be applied more frequently to maintain control over vigorous crops. Generally, foliar sprays of 2,500 to 5,000 ppm are applied every 10 to 14 days, as necessary. Daminozide

is labeled for use on containerized or bed-grown crops in the greenhouse and on containerized plants grown outdoors under nursery conditions. Frequency of application may need to be increased to weekly for more vigorous cultivars grown outdoors.

Chlormequat chloride (Citadel or Cycocel; REI = 12 hours) is another PGR with a long history in floriculture. Note that the product-use labels for these chlormequat chloride products vary in application limits. See the label for your product for the specific rates and sites of application (table 1). Chlormequat chloride is generally applied as a foliar spray at 200 to 3,000 ppm with a maximum of three to six applications per crop cycle, depending on which product you use. Rates above 1,500 ppm often cause chlorosis on young, treated leaves of floricultural crops. Chlormequat chloride also promotes earlier flowering and greater flower numbers on *Hibiscus* and geranium (*Pelargonium*).

Chlormequat chloride is also labeled for drench applications at rates of 2,000 to 4,000 ppm when applied inside a greenhouse, depending on the specific product label (table 1). Chlormequat drenches may not be economically advantageous.

Of these chlormequat chloride products, only Cycocel is labeled for use on containerized plants in the outdoor nursery where it may be applied at a maximum spray rate of 3,000 ppm up to three times in any crop production cycle. This limit includes any applications of Cycocel combined with daminozide. Drench applications of Cycocel are not permitted in the outdoor nursery, even on containerized plants. Read the pesticide label for your product: It is the law for application sites and rates. Chlormequat chloride is not labeled for application through the irrigation system.

A **daminozide/chlormequat chloride tank mix** has more PGR activity than either daminozide or chlormequat chloride alone and generally causes less phytotoxicity than chlormequat chloride applied by itself.

Both the daminozide and chlormequat chloride labels have approved tank mix instructions. The combination provides activity that ranges from low (800 ppm daminozide plus 1,000 ppm chlormequat chloride) to very high (5,000 ppm daminozide plus 1,500 ppm chlormequat chloride).

This tank mix has been tested on a wide variety of perennials. For example, three-lobed coneflower (*Rudbeckia triloba*) was very responsive to daminozide applied twice at 5,000 ppm but was not responsive to chlormequat chloride at rates up to 4,000 ppm. However, a tank mix of 5,000 ppm daminozide with increasing rates of chlormequat chloride resulted in height control similar to the daminozide treatments with a single application.

Although the rate of daminozide is usually adjusted to increase or decrease activity, changing the chlormequat chloride rate also affects activity. Single applications of the tank mix are frequently more effective than multiple applications of daminozide alone. However, multiple applications of the tank mix may be required for the more vigorous crops.

Flurprimidol (Topflor; REI = 12 hours) is similar in chemistry to ancymidol but much more potent. Its activity is similar to that of the triazoles. Many floricultural crops are responsive to flurprimidol. With spray applications, flurprimidol rates are similar to those used with paclobutrazol. However, in soil applications, its activity is more similar to that of uniconazole. Topflor is labeled for use as a spray, drench, or chemigation on containerized ornamental plants grown in nurseries, greenhouses, and shadehouses. Topflor is only recommended for a few bedding plant plugs and should never be used on the plugs of sensitive crops like begonia, pansy, salvia, or vinca. Flurprimidol is very active on most bulb crops, like tulips, Oriental lilies, callas, caladiums, and hyacinths, where it is applied as a drench when the new growth is about 1 inch tall or as a bulb soak prior to planting.

The triazole class of PGRs includes **paclobutrazol** (Bonzi, Downsize, Paczol, Piccolo, or Piccolo 10 XC; REI = 12 hours) and **uniconazole** (Concise or Sumagic; REI = 12 hours). These compounds are much more active than most of the previous compounds. Uniconazole is more potent than paclobutrazol.

As mentioned above, the activity of flurprimidol (Topflor) is between these two triazoles, depending on application method. These PGRs are rapidly absorbed by plant stems and petioles or through the roots. Excess spray dripping off treated plants acts as a drench to the substrate, increasing the activity of the treatment. For foliar sprays of triazoles, uniform application of a consistent volume per unit area is critical to uniform and consistent crop response.

Both compounds (see table 1) are labeled for application to the media surface prior to planting plugs. In this case, the PGR is applied as a spray to the surface of the

medium in filled pots. The PGR moves into the medium with subsequent irrigations and effectively behaves as a drench.

Take care with applications to sensitive plants. In some cases, excessive stunting can be persistent. These compounds must be used carefully and appropriately. Especially when working with the triazoles, thoroughly test your application methods and rates on a small number of plants before treating your entire crop. Avoid late applications of the triazoles. They should be applied prior to flower initiation when possible.

Paclobutrazol has a broad label for ornamentals that includes use on greenhouse or outdoor-grown, containerized crops. See table 1 for label restrictions for the different products. All of the paclobutrazol products are labeled for application through the irrigation system, including ebb/flow or flooded floor systems. Do not use paclobutrazol on annual vinca (*Catharanthus roseus*), because it causes spotting, or on fibrous begonias, which exhibit severe stunting with exposure to paclobutrazol.

To establish rates for plants not listed on the product label, treat a small number of plants with 30 ppm as a foliar spray or 1 ppm as a drench. In many cases, multiple treatments with lower rates have been more effective, with less chance of overstunting, than a single application at a higher rate.

Uniconazole also has a broad label for ornamentals, but its use is limited to containerized plants grown in greenhouses, overwintering structures, shadehouses, or lath houses. It is not labeled for outdoor nursery use. Uniconazole also is not labeled for application through any irrigation system. It has been very effective on a large number of floricultural crops. As with paclobutrazol, avoid using it on fibrous begonias. It is very potent, so pay special attention to proper mixing, uniform application, and proper volumes. Use caution in the higher rates or on more sensitive species, because uniconazole effects can be persistent even after the plant has been transplanted into the landscape.

NOTE: Ancymidol, flurprimidol, paclobutrazol, and uniconazole are persistent on plastic surfaces and in soil. Do not reuse flats, pots, or soil from treated plants — especially for plug production of sensitive crops.

Enhancing Lateral Branching

Another group of PGRs used in floricultural crops are those that enhance branching, including ethephon (Florel), benzyladenine (BA; Configure), dikegulac sodium (Atrimmec or Augeo), and methyl esters (Off-Shoot-O; table 2). These PGRs are frequently called chemical pinchers because they generally inhibit the growth of the terminal shoots or enhance the growth of lateral buds, thereby increasing the development of lateral branches. They can be used to replace mechanical pinching of many crops like *Vinca* vine, *Verbena*, *Lantana*, and English ivy (*Hedera*).

Ethephon (Florel brand Growth Regulator; REI = 48 hours) is a compound that breaks down in plant tissue after application to release ethylene, a natural plant hormone. As with ethylene, its effects can vary depending on the species and the stage of growth at time of application. Florel has a broad-use label (EPA Reg. No. 54705-8) for increasing lateral branching of floricultural crops and is commonly used on zonal and ivy geraniums and poinsettia to increase branching (figure 4).

Figure 4. Florel increases branching of geranium 'Designer Red' (left to right): no application, 350 ppm applied once, twice, and three times.

You may need to consider combinations of PGRs. For example, if you apply ethephon to enhance the branch development of Wave petunias in a hanging basket, you may still need to follow up with a treatment of a plant growth retardant to control the elongation of those new laterals.

Ethephon should be applied to actively growing plants prior to flower development. If flowers are present at the time of application, they are likely to abort. Ethephon may delay flowering by about one to four weeks, particularly if applied close to the time of flower initiation. Ethephon should not be applied to plants that are heat- or drought-stressed.

The pH of water used for the spray solution can be important. If the pH is too high, the ethephon will convert to ethylene before it gets to the plant, and activity

will be reduced. Florel contains sufficient acidifiers and buffers to maintain a pH of 5.0 or lower when mixed with most greenhouse water supplies. In general, water that has sufficient quality for irrigation of greenhouse crops (moderate pH and alkalinity) is suitable for mixing Florel. However, if you are acidifying your water prior to irrigation, use the acidified water for mixing the Florel as well. The solution should be applied within four hours of mixing.

Benzyladenine (6-BA Configure; REI = 12 hours). Configure is a synthetic cytokinin (6-benzyladenine), which is a plant hormone that stimulates lateral branching. It is a relatively inexpensive PGR that enhances branching of a wide variety of floricultural crops. BA stimulates, but does not cause, an increase in branching. Therefore, timing of the application is critical to a good branching response. Read the label for details on when to apply for optimum response because BA has a short period of activity and no residual in the plant. So, multiple applications may be useful with many crops. Furthermore, BA is not well-translocated in the plant, so thorough coverage is required.

Depending on the timing of the application, BA increases branching of the phylloclades or — when applied during floral initiation — increases the number of flower buds breaking on Christmas cactus. Configure at 500 to 3,000 ppm increased basal branching of *Hosta* and at lower rates, 300 to 600 ppm, for increased basal branching of *Echinacea*.

Further screening trials with other annuals and herbaceous perennials have identified a large number of crops with increased basal or lateral branching in response to BA. However, pansy is very sensitive to spray applications of BA with long-lasting leaf yellowing even at low rates (50 to 100 ppm). So, consider multiple applications at low rates. Due to leaf yellowing, do not use Configure on exacum. Several growers report successful use of Configure to increase the number of shoots on plugs and liners.

Although the primary objective with BA is to increase branching, it has resulted in growth reduction in some crops. However, if additional growth control is necessary, we have found that growth retardants may be used immediately following the BA treatment without reducing the branching response.

Dikegulac sodium (Augeo; REI = 4 hours) is a compound that delays terminal growth by interfering with cell-wall synthesis, which is required for new growth. By primarily inhibiting terminals, apical dominance is reduced, which enhances the production of lateral branches.

Augeo has a different carrier and is causing much less phytotoxicity (chlorosis) and crop delay than we previously saw with Atrimmec (PBI Gordon), which was the dikegulac sodium product previously labeled for nursery production. Augeo has a broad-use label for containerized greenhouse ornamentals as well as for container- or field-grown ornamentals and trees.

Augeo should be applied to actively growing plants with at least two nodes to provide sufficient lateral development. In addition to creating a fuller plant, enhancing the number of laterals in a pot generally reduces the overall height of the plant due to the greater distribution of resources. Dikegulac sodium usually causes leaf chlorosis and may delay growth resumption. Therefore, it is critical to apply it early in the production cycle. Augeo has effectively increased branching of plugs of many bedding plant crops, as well as geranium and herbaceous perennial liners. Responses are very species-specific, so test several rates (400 to 1,600 ppm) under your growing conditions.

Methyl esters (Off-Shoot-O; REI = 4 hours) are labeled for chemical pinching of actively growing azalea, cotoneaster, juniper, ligustrum, *Rhamnus*, and *Taxus*. Ensure good coverage of growing points to physically burn soft tissue. Do not apply to the same plants more than once, and do not apply to herbaceous plant material.

Plant Flowering

Plant growth regulators can be used to enhance flowering. To improve flowering, Florgib 4L, ProGibb T&O, or GA_3 4%, which contain the growth promoter gibberellic acid (GA_3), can be used to substitute for all or part of the chilling requirement of some woody and herbaceous ornamentals typically forced in the greenhouse, including azalea for florist crops and *Aster* for cut flowers. These compounds also can improve flowering and/or bloom size of camellia and baby's breath (*Gypsophila*), promote earlier flowering and an increased yield of statice (*Limonium*) and induce flowering of *Spathiphyllum*. Gibberellic acid is also used to promote growth and increase stem length of other cut flowers like stock (*Matthiola*), *Delphinium*, and 'Sweet William' (*Dianthus*). See product labels for specific uses and recommended rates.

Table 2. Other plant growth regulators used in the production of floricultural crops.

Common name Trade name	**Application methods**	**Comments**	**Concerns**
Ethephon **Florel brand Growth Regulator** (Monterey Lawn and Garden Products Inc.)	Foliar spray	Promotes lateral branching, thereby reducing stem elongation. Also aborts flowers; improves stock plant branching and cutting yield. Use early in crop cycle to increase branching and remove early flowers (6-8 weeks before flowering). Reduces height and stem topple of potted daffodils and hyacinths.	The pH of spray solution should be less than 5.0. Use within 4 hours of mixing. Results less predictable under high temperature conditions. Do not treat plants under environmental stress conditions.
Benzyladenine **Configure** (Fine Americas Inc.)	Foliar spray	Enhances lateral branching of greenhouse-grown containerized ornamentals. Not labeled for chemigation.	May need to add wetting agent for waxy crops. Not translocated in the plant, so thorough plant coverage required. Short residual; multiple applications may improve response.
Benzyladenine/ GA_{4+7} **Fascination (**Valent USA) **Fresco** (Fine Americas Inc.)	Foliar spray	Growth promoter and labeled for prevention of leaf yellowing and to delay flower senescence of Easter, Oriental, and *Lilium longiflorum* x *asiatic* (LA) hybrid lilies. Labeled for growth promotion to overcome growth-retardant effects on containerized and field-grown ornamentals.	Effective dose strongly affected by volume (soil-active). Thorough coverage required. Avoid application to plants under conditions of environmental stress. To overcome stunting, start with low rates, 1-3 ppm*. Repeat in 5 days, if necessary.
Gibberellic acid (GA_3) **Florgib 4L** (Fine Americas Inc.) **GA_3 4%** (Greenleaf Chemical LLC) **ProGibb T&O** (Valent USA)	Foliar spray	Growth promoter. Broad-use label. Labeled for: substitution of cold to force flowering azaleas; inhibition of flower buds on vegetative azaleas; peduncle elongation of pompom mums; earlier flowering and increased yield of statice; induction of flowering of spathiphyllum. **ProGibb T&O** and **GA_3 4%** are labeled for growth promotion to overcome growth-retardant effects on containerized and field-grown ornamentals.	Overapplication or incorrect timing can cause weak stems and excessive stem elongation. Very potent growth promoter. Start with 1 ppm on most crops.
Dikegulac sodium **Augeo** (OHP Inc.)	Foliar spray	Broad label lists greenhouse, nursery, and field production sites. Inhibits terminal growth, thereby promoting lateral development. Apply to actively growing plants with at least two nodes to provide sufficient lateral development.	May delay plant development, especially at higher rates. Adjust water and fertilizer according to growth. Causes leaf chlorosis, which may be persistent at high rates. Do not pinch or prune soon after treatment. Do not add wetting agents.

* ppm = parts per million

Table 2. Other plant growth regulators used in the production of floricultural crops. (cont.)

Common name Trade name	**Application methods**	**Comments**	**Concerns**
Methyl esters of fatty acids	Foliar spray	Labeled for chemical pinching of actively growing azalea, cotoneaster, juniper, ligustrum, *Rhamnus*, and *Taxus*.	Ensure coverage of growing points. Do not spray more than once.
Off-Shoot-O (Cochran Corp.)			

* ppm = parts per million

Again, timing is critical, because late applications or excessive rates may cause excessive plant stretching, resulting in weak, spindly stems. Chlormequat chloride (a plant growth retardant) used to control stem height of hibiscus and geranium also improves early flowering of these crops.

Removal of Flowers

Flower removal is especially desirable for stock plants maintained for cuttings of vegetatively propagated ornamentals, like *Verbena* or *Lantana*. Ethephon (Florel) is the primary compound used for flower removal. Once ethephon is absorbed by the plant, it is converted to gaseous ethylene — a natural plant hormone effective in many plant processes. Ethylene is the primary hormone responsible for flower senescence and fruit ripening. It is the "postharvest" hormone. With proper rates and timing, it will remove unwanted flowers from stock plants, cuttings, or plugs. Flower removal diverts more energy into vegetative growth, increases the number of laterals available for cuttings on stock plants, and promotes increased branching of plugs and finished plants, which increases fullness in the container. Because initiation and development of flowers require time, ethephon should not be used on crops within six to eight weeks of marketing.

Other PGR Uses

Another specific application of the gibberellin and cytokinin products (Fascination or Fresco) is the reduction of lower leaf yellowing on Easter, Oriental, and LA hybrid lilies. See the label for detailed instructions. These products also may be used to increase bract expansion in poinsettias. Fascination, Fresco, ProGibb T&O, and GA_3 4% are labeled to promote the growth of plants that have been overregulated by plant growth retardants. These PGRs are very potent growth promoters. Start with low rates, 1 to 3 ppm, and apply at five-day intervals as necessary.

Read the Label!

Plant growth regulators are classified as pesticides. Therefore, they are subject to all of the same U.S. Department of Agriculture (USDA) recordkeeping and Worker Protection Standard (WPS) rules as all of your other pesticides. Their use is governed by the manufacturer's label, as with other pesticides. The label not only contains information on restrictions, but also much information on how to use the product effectively. Before going to the time and expense of applying PGRs to your crop, answer these questions:

- Is the chemical labeled for the crop you wish to treat? Most PGR labels have undergone revisions that apply to a broad range of similar crops not specifically listed on the label, with the user taking responsibility for determining appropriate rates. This provides label permission to use the compound on these crops without the manufacturer accepting the responsibility for the rate selection.

- Is the chemical labeled for the area you wish to treat? Many of the PGRs are only labeled for use inside a greenhouse or other growing structure.

- Are there any potential side effects, such as phytotoxicity? Note that you may need to look elsewhere for this information for your specific crop.

- Are there label warnings regarding the PGR's effect on plant flowering? For example, many branching enhancers delay flowering. Florel causes flower bud abscission prior to enhancing branching; therefore, is not recommended within six to eight weeks of marketing. Side effects are frequently affected by the timing of the application; e.g., late applications of growth retardants may delay flowering.

Always follow the label for mixing and application instructions. Many of these products require thorough shaking before dispensing. For best results, use only

clean equipment that is dedicated to PGRs. Do not use sprayers that may contain other pesticide residues. In general, PGR labels restrict the addition of wetting agents and tank mixing with other pesticides or fertilizers. See the label for specific applications that recommend additional adjuvants. Follow label directions exactly when mixing PGR solutions, and apply them on the same day as they are prepared. Store PGRs tightly sealed in their original containers in a cool, dry, dark place.

Application Guidelines

Spray Applications

Plants to be treated with PGRs should be healthy, turgid, and unstressed – never wilted. The label will identify the target tissue for that PGR. For example, daminozide is only effective as a foliar spray, whereas paclobutrazol and uniconazole sprays must reach the stems. When making spray applications, look at the growth and development of the plant to see that there is sufficient development to make the treatment effective and accomplish your goal. Generally, there should be sufficient foliage or stems to absorb the PGR.

Uptake and effectiveness of a PGR also depend on selecting the application technique that will ensure proper coverage of the target tissue. Daminozide is not soil-active. Therefore, a foliar spray application, wetting most of the foliage, is necessary to provide a uniform reduction in growth. Leaf surfaces should be dry for foliar applications, and the best uptake of PGRs from spray applications will occur under low-stress, low-drying conditions. This is more critical for daminozide and ethephon than for some of the newer chemistries, like the triazoles. Overhead irrigation after treatment with daminozide or ethephon should be delayed for 18 to 24 hours to avoid washing the material off of the leaves.

The triazoles — paclobutrazol and uniconazole — are absorbed primarily by stem tissue and then translocated upward in the plant. Therefore, consistent and complete coverage of the stems is necessary for uniform effects. In other words, if the stem of one lateral receives an inadequate amount of spray, it will grow faster than the others, resulting in a poorly shaped plant, most noticeable in potted crops like poinsettia or chrysanthemum. Ancymidol and flurprimidol are taken up by both foliage and stems. In addition, all four of these compounds are very "soil-active," which means they may be adsorbed to particles in the media and become available to the plant through root uptake. Therefore, drenching is a very effective application method for these chemicals in crops where it is economically feasible (see Applying Drenches, below).

The label will provide a recommended application volume for sprays, especially for chemicals that are soil-active. All foliar applications of PGRs should be applied on an area basis, i.e., uniformly spray the area where the plants are located with the recommended volume of solution. DO NOT spray individual plants or spray to reach a subjective target like "spray to glistening." Since every applicator will have a slightly different definition of these goals, there will be no way of recommending appropriate rates or obtaining predictable results.

For soil-active PGRs, dosage is dependent on both the concentration of the solution and the volume of that solution applied in the treated area. Therefore, to improve predictability, the label-recommended spray application rates are generally set at 2 quarts of finished spray per 100 square feet, which is sufficient to cover the plant and permit a small amount of runoff onto the substrate. It also is considered to be a comfortable walking pace for applicators with hand-held sprayers. This is the same application volume recommended for daminozide, which is not soil-active.

With the soil-active PGRs, precautions should be taken to avoid overapplication with sprays. Spray applications require more attention to detail, because overspray material lands or drips onto the medium. The overspray from a 2 quart per 100 square feet application is a part of the recommended dosage. However, if your application volume exceeds that recommendation, then your application dosage also exceeds the recommendation (figure 5).

Figure 5. Effect of increasing volume of PGR spray application on height control. Left to right, vinca (*Catharanthus roseus*) untreated or treated with 1 ppm uniconazole at the label-recommended volume of 2 quarts per 100 square feet, 3 quarts per 100 square feet, and 4 quarts per 100 square feet.

Recognizing that stem coverage is necessary for the triazoles, you may need to apply a higher-than-recommended volume to large or dense plants to obtain adequate coverage. In fact, the paclobutrazol label recommends a spray volume of 3 quarts per 100 square feet for "larger plants with a well-developed canopy." Adjust the concentration you apply accordingly. This suggests the importance of recordkeeping (see Recordkeeping, below). Always consider the rates presented in the appendix, on PGR product labels, or from any other resource, to be **guidelines** to assist you in developing your own rates based on your growing conditions and application methods.

The relationship of rate and volume can be exploited when treating multiple crops with different PGR needs. With a single solution of PGR in the spray tank, you can apply the label-recommended volume to attain your basic application dosage, or you can apply additional volume to crops that need additional growth regulation to attain a higher dosage. Application volume is another tool you can use to maximize your efforts and reduce time mixing or reloading higher concentrations of PGR solutions.

Spray Equipment

To assure proper spray volumes, your compressed air sprayer should be equipped with a pressure gauge and regulator, and you should consistently use the same nozzle for all PGR applications. Your sprayer should be calibrated by determining the output of the chemical with the selected nozzle at the selected pressure within a specified time period. Using this information, you can apply a known amount of material to a known area.

Spray droplet size also affects response, with smaller droplet sizes providing better coverage — but only up to a point. Mist- or fog-type applicators do NOT provide adequate volume for coverage of plant stems and the medium, and therefore, have not been effective when used with compounds like paclobutrazol and uniconazole. PGR applicators should be trained to uniformly apply a given amount of clear water in the greenhouse before they make PGR applications. Uniformity of the application is critical to the uniformity of the crop response.

Applying Drenches

Although drench application has several advantages over sprays, traditional drenches are seldom used on perennials due to the higher application costs of handling individual pots. Drenches generally have a less negative effect on flowering or flower size and tend to provide longer-lasting growth regulation than sprays. Drenches are easier to apply uniformly than sprays because the drench volume is easily measured; when applied to moist substrate, it is easy to obtain good distribution of the PGR in the media. Therefore, the resulting growth regulation is frequently more uniform.

The product label specifies the recommended volumes for drench applications to different size pots or types of media. In general, 4 fluid ounces of drench solution is applied to a 6-inch "azalea" pot, and that volume is adjusted up or down with pot size to obtain a volume where about 10 percent of the solution runs out of the bottom of the pot when the substrate is moist.

Remember that the amount of active ingredient (a.i.) applied to plants depends on both the concentration (ppm) of the solution and the volume applied. **Read the label.** Table 3 provides a general table of volume recommendations for drench applications.

Table 3. Volume recommendations for drench applications.

Pot diameter (inches)	Drench volume (fl oz/pot)	Drench volume (ml/pot)
4	2	60
5	3	90
6	4	120
8	10	300
10	25	750
12	40	1,200

Alternative methods of applying PGRs directly to the substrate have been developed and are described on the label. For example, ancymidol, flurprimidol, and paclobutrazol are labeled for application through the irrigation system (chemigation). These are generally labeled for flood (subirrigation), drip irrigation, and overhead sprinkler systems. Again, rates vary with the volumes used and method of application. Paclobutrazol applied once by subirrigation requires 50 percent to 75 percent of the amount of paclobutrazol that is applied in a typical drench application.

Pressure-compensated drippers are recommended for use with PGRs to more accurately regulate the volume of solution applied to each pot. Read and exactly follow the label for chemigation applications, especially with regard to safety of municipal water supplies.

Three other methods of providing a drench-type application of soil-active PGRs on a more economical scale are being used by growers: substrate surface application sprays, sprenches, and watering in.

Substrate surface application sprays are spray applications made to the surface of the substrate of filled flats or pots. The treatment is applied at normal-to-high spray volumes, but because it is applied to the substrate surface, it is activated by irrigation and is available to the plant in the root zone. Both paclobutrazol and uniconazole are labeled for this method of application. Rates are lower than those used for sprays but higher than those used for drench applications.

Sprenches, the second method, is a high-volume foliar spray that results in additional runoff into the substrate, providing a drench effect. Rates are lower than for recommended for spray rates.

Watering in is a type of chemigation where the PGR is injected into the irrigation water and applied at each irrigation at very low rates of active ingredient. Only PGRs labeled for chemigation can be used for watering in.

All of these application methods use the relationship between rate and volume to provide the desired control. Again, you must develop techniques that fit your production methods and your growth management preferences.

Liner dips or drenches are another specialized way to use soil-active growth retardants. The root system of rooted liners or plugs is dipped into a solution of the PGR (or they may be thoroughly drenched in the plug tray). Extensive work has been conducted at the University of Florida on this application method:

- Liners should be "dry," which is defined as the root ball being ready for irrigation plants but not under drought stress.
- Time in the solution is not critical; 30 seconds to two minutes is sufficient for saturation of the rootball.
- Liners may be planted immediately or held up a few days without loss of PGR effect.
- There is no loss of effectiveness of the dip solution during treatment.

Advantages of the liner dip include early control of very vigorous crops and flexibility of the treatment with respect to not having to handle plants during the restricted-entry interval. The liner dip is especially useful in combination plantings where the more vigorous plants can be treated prior to planting without reducing the growth of the slower plants in the group. The liner dip rates should be selected to provide early control of plant growth. Additional PGR applications can be made as necessary for longer term crops.

Be Aware of Bark

For many years, the adage in PGR drenches has been, "Bark ties up soil-active PGRs." However, new research shows that this is not necessarily true. As long as the bark is properly aged before the media is mixed, it has little effect on the availability of these soil-active PGRs to the plant roots. Again, you must identify PGRs and rates that work with your production system.

Growing Conditions

Look also for label recommendations on time of day or condition of the plant for optimum treatment response. Generally, a healthy, unstressed plant growing under low evaporative conditions, e.g., early in the morning or late in the afternoon, is most responsive to treatment.

To maximize uptake, the chemical must remain in contact with the leaf long enough to be absorbed. This time varies for the different PGRs, but generally, foliar uptake is enhanced with slower drying conditions, which in turn increases the effectiveness of the treatment. This is especially important with foliar uptake of PGRs, such as daminozide, chlormequat chloride, BA, or ethephon. Plants treated with daminozide or ethephon should not be overhead irrigated for at least 18 to 24 hours after treatment, but plants treated with flurprimidol, paclobutrazol, or uniconazole may be irrigated one hour after treatment. Read the label for any warnings on how irrigation or environmental conditions will affect plant response to the PGR treatment.

Recordkeeping

Keeping notes on your application methods and the results of your PGR treatments will allow you to improve the consistency of your own application methods and establish rates and volumes appropriate for your production system. Note the concentration and volume applied, the stage of development of the crop (number of leaves, approximate height, presence of flowers), and the environmental conditions under which the PGR was applied. It is always recommended to keep a few untreated plants for comparison, especially if you are new to using PGRs (figure 6).

Figure 6. An untreated check lets you determine how effective a plant growth regulation treatment is under your conditions.

Summary

The degree of growth regulation caused by PGRs is impacted by all other phases of plant culture. Remember that you have to fit PGRs into your own production program. Plan ahead to achieve the best results from PGRs; do not use them as an afterthought when the plants are out of control. You cannot shrink an overgrown plant!

The multitude of variations possible in application methods, cultivar and species grown, and growing conditions makes it impossible to recommend specific rates for all operations. Use the product labels and the appendix as resources for the use of PGRs on a variety of crops. Use the lower of suggested effective rates for starting your own trials.

There are two general rules for using rate recommendations from other sources:

1. Southern growers use higher rates and more frequent applications than Northern growers. Rates for Virginia/North Carolina tend be closer to the Southern rates.

2. Outdoor applications usually require higher rates or more frequent applications than plants grown under cover.

Always consider any rate recommendation as a starting point for your own trials and keep records of your successes and failures with PGRs. When you treat your crop, hold back a few untreated plants so you can judge the effectiveness of your treatment (figure 7). Remember that methods of application have significant effects on results. Develop your own program, then test and refine it. Watch for PGR compounds new to the floriculture market and for expanded labeling of current products as we develop more guidelines for their use on floricultural crops.

Figure 7. Conduct your own greenhouse trials to determine the suitability of plant growth regulators on the cultivars grown under your conditions.

Recommended Resources

PGR Calculator

For a ready resource on preparing PGR solutions, utilize the plant growth regulator calculator (PGRCALC) developed by floriculture specialists from North Carolina State University and the University of New Hampshire Cooperative Extension: http://extension.unh.edu/agric/AGGHFL/Plantgrowthregulatorcalculator.cfm. This online calculator allows you to enter your own PGR costs and calculate solutions based on the rate desired and the amount of area to be treated. The program includes information on both spray and drench applications. It not only gives you the amount of PGR to mix per gallon or liter of water, it also provides the cost of the application based on the area or number of containers treated.

A PGR mixing application for a variety of mobile devices also has been developed at the University of New Hampshire and can be downloaded at: http://extension.unh.edu/Agric/AGGHFL/PGRMixMasterHome.htm

Helpful Conversions

Volume

1 gallon (gal) = 128 fluid ounces (fl oz)

1 fl oz = 30 milliliters (ml)

1 gal = 3,785 ml = 3.785 liters

1 cup = 48 teaspoons

1 tablespoon = 3 teaspoons

1 fl oz = 2 tablespoons = 6 teaspoons

Weight

1 ounce (oz) = 28.3 grams (g)

1 pound (lb) = 16 oz = 454 g

Concentration

1% = 10,000 ppm

1 ppm = 1 milligram (mg) per liter

Disclaimer

Commercial products are named in this publication for informational purposes only. Virginia Cooperative Extension does not endorse these products and does not intend discrimination against other products which also may be suitable.

Appendix. Growth regulators for floricultural crops in greenhouses.

This table lists labeled rates of plant growth regulators for greenhouse crops, as well as recommendations based on research at North Carolina State University and recommendations by suppliers. Read labels for a complete listing of precautions. The degree of control can vary depending on a number of factors, including plant type, cultivar, stage of development, fertilization program, growing temperatures, and crop spacing.

When using a PGR for the first time, it's good to test the rate on a few plants prior to spraying the entire crop. Keep accurate records and adjust rates for your location.

General recommendations: Plug culture and flat culture have different recommended rates. The rates in this table include recommendations for both plug (lower rates) and flat culture (higher rates). Apply ALL foliar sprays of plant growth regulators using 0.5 gallon per 100 square feet of bench area.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
Bedding plants (General)	To control plant height	Ancymidol	Abide, A-Rest	6-66 ppm[1] spray (2.9-32 fl oz[2]/gal[3])	Plug culture and flat culture differ in recommended rates. The rates shown in this table include both plug (lower rates) and flat culture (higher rates) recommendations. Apply ALL foliar sprays of plant growth regulators using 0.5 gal/100 sq ft[4] of bench area.
				0.06.-0.12 mg[5] a.i.[6] drench for a 4-inch pot (0.5-1.0 fl oz/gal of drench solution; apply 2 fl oz/4-inch pot)	Drench volumes and mg a.i. vary with pot size.
		Daminozide + chlormequat chloride	B-Nine, Dazide + Citadel, Cycocel	800-5,000 ppm daminozide (0.13-0.79 oz/gal) + 1,000-1,500 ppm chlormequat chloride (1.08 to1.63 fl oz/gal) applied as a tank-mix spray	Use the highest rate of chlormequat chloride that doesn't cause excessive leaf yellowing, and adjust the daminozide rate up and down within the labeled range to attain the desired level of height control.
		Paclobutrazol	Bonzi, Paczol, Piccolo	5-90 ppm spray (0.16-2.88 fl oz/gal); use 230 ppm spray (0.96 fl oz/gal) as a base rate and adjust as needed.	Conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control. Not recommended for use on fibrous begonia or vinca.
		Paclobutrazol	Bonzi, Downsize, Paczol, Piccolo	0.118 mg a.i. drench for a 6-inch pot (0.032 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drench applications are recommended only for bedding plants in 6-inch or larger containers. Not recommended for use on fibrous begonia or vinca.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
Bedding plants (General) (cont.)		Chlormequat chloride	Citadel, Cycocel	800-1,500 ppm spray (0.87-1.63 fl oz/gal)	Conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control.
		Uniconazole	Concise, Sumagic	1-50 ppm spray (0.23-11.64 fl oz/gal)	Conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control. Apply spray as elongation begins (plant height about 2-4 inches).
				0.1-2.0 ppm drench (0.03-0.51 fl oz/gal)	
	To promote plant growth and overcome over- application of gibberellin- inhibiting PGRs	Gibberellic acid	GA_3 4%, ProGibb T&O	1-25 ppm spray (0.003-0.09 fl oz/gal)	Conduct trials on a small number of plants initially using 1 ppm, unless previous experience warrants higher use rates. Following assessment of plant response and if desired results were not evident, reapplication or an increase in rate may be warranted. Consult the label for additional precautions.
		6-benzyladenine + gibberellins A_4A_7	Fascination, Fresco	1-25 ppm spray (0.02-0.18 fl oz/gal)	Conduct trials on a small number of plants initially using 1 ppm, unless previous experience warrants higher use rates. Following assessment of plant response and if desired results were not evident, reapplication or an increase in rate may be warranted. The most common rates for use are 3-5 ppm. **See label for additional precautions before use.**
	To induce lateral or basal branching	6-benzyladenine	Configure	50-500 ppm spray (0.3-3 fl oz/gal)	The supplemental label allows legal use on greenhouse-grown plants not specifically listed on the original label. **See label for trialing suggestions and precautions.**
		Dikegulac sodium	Augeo	400-800 ppm spray (0.25-0.5 fl oz/gal)	OHP reports excellent results with 400 ppm applied to plugs of many bedding plant crops. Test 800 ppm on finished crops. Make one application early in production cycle.
CHRYSANTHEMUM, Potted	To control plant height	Ancymidol	Abide, A-Rest	25-50 ppm spray (12.1-24.2 fl oz/gal)	

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
CHRYSANTHEMUM, Potted (cont.)				0.25-0.5 mg a.i. drench for a 6-inch pot (1-2 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Apply when plants are 2-6 inches tall (about 2 weeks after pinch). Drench rates and application volumes vary with pot size.
		Daminozide	B-Nine, Dazide	1,000 ppm preplant foliar dip (0.16 oz/gal)	Rooted cuttings can be dipped in solution to thoroughly wet leaves and stems and then potted. Allow foliage to dry before watering in. For unrooted cuttings, dip stems in solution, remove to flat, cover to prevent dehydration, and hold overnight under cool conditions. Stick the next day.
				2,500-5,000 ppm spray (0.39-0.79 oz/gal)	Spray when new growth from pinch is 1-2 inches long. Some varieties may require another application 3 weeks later.
		Paclobutrazol	Bonzi, Paczol, Piccolo	50-200 ppm spray (1.6-6.4 fl oz/gal)	Applications should begin when axillary shoots are 2-3 inches long. Sprays can be applied earlier to vigorous cultivars if additional control is desired. Sequential applications of lower rates generally provide more uniformly shaped plants than single-spray applications.
		Paclobutrazol	Bonzi, Downsize, Paczol, Piccolo	0.118-0.473 mg a.i. (1-4 ppm) drench for a 6-inch pot (0.032-0.128 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drench volumes and mg a.i. vary with pot size. Begin when the axillary shoots are 2-3 inches long. Uniform application is required.
		Uniconazole	Concise	5-10 ppm dip treatment on cuttings (1.16-2.33 fl oz/gal)	Apply when the lateral shoots are 1.5-2.0 inches tall (about 7-14 days after pinching). Test for cultivar sensitivity. Multiple applications of the lower label rate and/or increasing the spray volume from 2 qt/100 sq ft to 3 qt/100 sq ft may elicit a more satisfactory response. **For Florida only:** Use a foliar spray concentration of 5-10 ppm (1.16-2.33 fl oz/gal). For medium-to-tall cultivars, increase the spray volume to 3 qts/100 sq ft.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
CHRYSANTHEMUM, Potted (cont.)				2.5-10 ppm spray (0.58-2.33 fl oz/gal)	Apply as a dip treatment on unrooted cuttings followed by a foliar spray in the low rate range. On rooted cuttings, use a solution of 2.5 ppm or less, followed by a foliar spray in the low rate range.
		Uniconazole	Sumagic	2.5-10.0 ppm spray (0.58-2.33 fl oz/gal)	
		Fluprimidol	Topflor	7.5-25.0 ppm spray (0.25-0.84 fl oz/gal)	Based on N.C. State University trials. Adjust rates for other locations. Use lower rates for less vigorous cultivars.
	To increase lateral branching.	Dikegulac sodium	Augeo	400 ppm spray (0.25 fl oz/gal)	Severe yellowing at higher rates.
COLEUS, Vegetative	To control plant growth	Daminozide + chlormequat chloride	B-Nine, Dazide + Citadel, Cycocel	2,500-4,000 ppm (0.39-0.63 oz/gal) + 1,000-1,500 ppm chlormequat chloride (1.08-1.63 fl oz/gal) applied as a tank-mix spray	**See General Recommendations.** Scheduling the crop to avoid excessive stretch is an effective means of controlling growth.
		Paclobutrazol	Bonzi, Paczol, Piccolo	5-30 ppm spray (0.16-0.96 fl oz/gal)	
		Paclobutrazol	Piccolo	6-10 ppm liner root soak (0.192-0.32 fl oz/gal)	Irrigation of the liners occurred within 24 hours prior to application, which results a moderately dry substrate (the stage the plants would be watered, but not wilted). Soak for a minimum of 30-60 seconds. Transplant after 3-hour waiting period. Rate based on Michigan State University trials.
		Chlormequat chloride	Citadel, Cycocel	800-1,500 ppm spray (0.87-1.63 fl oz/gal)	
		Uniconazole	Concise, Sumagic	10-20 ppm spray (2.33-4.65 fl oz/gal)	
	To increase lateral branching	Dikegulac sodium	Augeo	800-1,600 ppm spray (0.5-1.0 fl oz/gal)	Apply once to unpinched plants when shoots are 1-3 inches long or within 3 days of pinching.
GERANIUM	To control plant height	Ancymidol	Abide, A-Rest	26-66 ppm spray (12.6-32 fl oz/gal	
		Paclobutrazol	Bonzi, Paczol, Piccolo	5-30 ppm spray (0.16-0.96 fl oz/gal)	Apply to zonal geraniums when new growth is 1.5-2.0 inches long. Apply to seed geraniums approximately 2-4 weeks after transplanting.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
GERANIUM (cont.)		Uniconazole	Concise	3-8 ppm spray (0.7-1.86 fl oz/gal)	Use lower rates for less vigorous plants and higher rates for more vigorous growing plants. Flower delay on some cultivars can occur when using rates >6 ppm.
		Chlormequat chloride	Citadel, Cycocel	800-1,500 ppm spray (0.87-1.63 fl oz/gal)	Make first application 2-4 weeks after planting plugs or rooted cuttings (after stems have started elongating). Multiple applications may be needed.
		Uniconazole	Sumagic	3-6 ppm spray (0.07-1.4 fl oz/gal) for cutting geraniums and 2-4 ppm spray (0.47-0.93 fl oz/gal) for seed geraniums	
		Fluprimidol	Topflor	15-25 ppm spray (0.5-0.83 fl oz/gal)	Apply to zonal geraniums when new growth is 1.5-2 inches long.
	To promote earlier flowering in seed geraniums	Chlormequat chloride	Citadel, Cycocel	1,500 ppm spray (1.63 fl oz/gal)	Make two applications at 35 and 42 days after seeding. Treated plants should flower earlier and be more compact and more well-branched than untreated plants.
		Gibberellic acid	GA_3 4%, ProGibb T&O	5-15 ppm spray (0.02-0.06 fl oz/gal)	Make a single foliar application when first flower bud set is noted. Spray the entire plant until runoff. See label for precautions.
	To increase flower number and size in cutting geranium	Gibberellic acid	GA_3 4%, ProGibb T&O	1-5 ppm spray (0.003-0.02 fl oz/gal)	Make a single foliar application when first flower bud set is noted. Spray the entire plant until runoff. See label for precautions.
	To increase lateral branching	Dikegulac sodium	Augeo	400-800 ppm spray (0.25-0.5 fl oz/gal) on liners	OHP Inc. reports excellent branching of rooted liners of zonal and ivy geraniums. Labeled rate for finished ivy geraniums is 1,600 ppm.
				1,600 ppm spray (1.0 fl oz/gal) on ivy geranium	
		Ethephon	Florel	300-500 ppm spray (1.0-1.62 fl oz/gal)	Labeled for zonal and ivy geraniums. Use the lower concentration for ivy geraniums. Florel will also provide some growth-retardant effect and delay flowering. Read the label for restrictions on timing of applications.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
LILY, Easter	To control plant height	Ancymidol	Abide, A-Rest	30-132 ppm spray (14.5-64 fl oz/gal). Use 50 ppm spray (24.2 fl oz/gal) as a base rate and adjust as needed.	Apply when newly developing shoots are 2-3 inches long; a second application when shoots average 6 inches long may be needed.
				0.25-0.5 mg a.i. (2-4 ppm) drench for a 6-inch pot (1-2 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Single drench should be applied when shoots average 3-5 inches long. Drench volumes and mg a.i. vary with pot size.
		Uniconazole	Concise	3-15 ppm spray (0.70-3.49 fl oz/gal)	Apply when shoots average 3 inches tall. It is best to make only one foliar application per crop.
				0.03-0.06 mg a.i. (0.25-0.50 ppm) drench for a 6-inch pot (0.059-0.118 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Apply when shoots average 3 inches tall. Use lower rates on cultivars, such as 'Nellie White,' and higher rates for 'Ace.' **For Florida only:** Use a solution concentration of between 0.05-0.12 mg a.i. (0.4-1.0 ppm) drench for a 6-inch pot (0.11-0.26 fl oz/gal of drench solution, apply 4 fl oz/6-inch pot).
		Uniconazole	Sumagic	3-15 ppm spray (0.70-3.49 fl oz/gal)	Apply when shoots average 3 inches tall.
				0.03-0.06 mg a.i. (0.25-0.5 ppm) drench for a 6-inch pot (0.059-0.118 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drench volumes and mg a.i. vary with pot size.
	To prevent leaf yellowing	6-benzyladenine + gibberellins A_4A_7	Fascination, Fresco	5-10 ppm spray (0.04-0.07 fl oz/gal)	Apply early season (7-10 days PRIOR to visible bud stage) and mid-season (7-10 days AFTER visible bud stage). Apply spray only to lower leaves to minimize stem elongation. **See label.**
	To prevent leaf yellowing and prolong flowering	6-benzyladenine + gibberellins A_4A_7	Fascination, Fresco	100 ppm spray (0.71 fl oz/gal)	Apply late season (when first bud reaches at least 3 inches in length) and no more than 14 days prior to placement in a cooler or shipping. Apply to foliar and flower buds. **See label.**

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
LILY, Hybrid	To control plant height	Paclobutrazol	Bonzi, Paczol, Piccolo	200-500 ppm spray (6.4-16.0 fl oz/gal)	Make first spray application when plants are 2-4 inches tall.
				5-30 ppm bulb soak (0.16-0.96 fl oz/gal)	Soak bulbs in the solution for 15 min prior to planting.
		Paclobutrazol	Bonzi, Downsize, Paczol, Piccolo	0.25-0.50 mg a.i. (4-30 ppm) drench for a 6-inch pot (0.14-0.96 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Single drench should be applied when shoots average 3-5 inches long. Drench volumes and mg a.i. vary with pot size and cultivar.
		Uniconazole	Concise	2.5-20.0 ppm spray (0.64-4.65 fl oz/gal)	Conduct a trial to determine optimal rates for each cultivar and adjust the rate as needed. Spray when shoots average 3 inches tall. If a second application is needed or a split application is made, it should be applied when the shoots average 6 inches tall. Usually two applications of foliar sprays at a lower rate are more effective than one application at a higher rate. Avoid applications after visible bud stage.
				1-3 ppm drench (0.23-0.70 fl oz/gal)	Drench volume varies with pot size. Applications should be made when newly emerged shoots are 1-2 inches tall.
				1-10 ppm bulb soak (0.23-2.33 fl oz/gal)	Treatment soak time should range from 1-5 minutes. Soak time will vary depending on bulb size, cultivar, and final desired height. Lower rates may require longer soak times (5-10 minutes) than higher rates (1 minute).
		Uniconazole	Sumagic	3-15 ppm spray (0.70-3.49 fl oz/gal)	Apply when shoots average 3 inches tall.
				0.03-0.06 mg a.i. (0.25-0.50 ppm) drench for a 6-inch pot (0.059-0.118 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drench volumes and mg a.i. vary with pot size.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
LILY, Hybrid (cont.)		Fluprimidol	Topflor	0.25-0.50 mg a.i. (2.1-4.2 ppm) drench for a 6-inch pot	Based on N.C. State University trials. Adjust rates for other locations.
	To prevent leaf yellowing	6-benzylade-nine + gibberel-lins A_4A_7	Fascination, Fresco	5-10 ppm spray (0.04-0.07 fl oz/gal)	Apply early season (7-10 days PRIOR TO visible bud stage) and mid-season (7-10 days AFTER visible bud stage). Apply spray only to lower leaves to mini-mize stem elongation. See label.
	To prevent leaf yellowing and prolong flowering	6-benzylade-nine + gibberel-lins A_4A_7	Fascination, Fresco	100 ppm spray (0.71 fl oz/gal)	Apply late season (when first bud reaches at least 3 inches in length) and no more than 14 days prior to placement in a cooler or shipping. Apply to foliar and flower buds. See label.
LILY, Oriental	To control plant height	Paclobutrazol	Bonzi, Paczol, Piccolo	100-200 ppm bulb soak (3.2-6.4 fl oz/gal)	Ten-minute soaks provided excellent results in N.C. State University trials. Cultivar response varied.
		Uniconazole	Concise	2.5-10.0 ppm spray (0.58-2.33 fl oz/gal)	See Concise label comments for hybrid lilies.
		Uniconazole	Concise, Sumagic	1-10 ppm bulb soak (0.23-2.33 fl oz/gal)	See Concise label comments for hybrid lilies. 10-minute pre-plant soaks of 5 ppm (1.16 oz/gal) provided excellent results in N.C. State University trials. Cultivar response varied.
		Fluprimidol	Topflor	0.5 mg a.i. drench (4.2 ppm); (0.14 fl oz/gal; apply 4 fl oz/6-inch pot).	Optimal rate base on N.C. State University trials. Adjust rate for plant vigor. Drench volumes and mg a.i. vary with pot size.
				25 ppm bulb soak (0.84 fl oz/gal)	Ten-minute preplant soaks pro-vided excellent results in N.C. State University trials. Cultivar response varied.
	To prevent leaf yellowing	6-benzylade-nine + gibberel-lins A_4A_7	Fascination, Fresco	100 ppm spray (0.71 fl oz/gal)	Apply early season (7-10 days PRIOR to or AFTER visible bud stage). Apply spray only to lower leaves to minimize stem elongation. **See label.**
	To prevent leaf yellowing and prolong flowering	6-benzylade-nine + gibberel-lins A_4A_7	Fascination, Fresco	100 ppm spray (0.71 fl oz/gal)	Apply late season (no more than 14 days prior to place-ment in a cooler or shipping). Apply to foliar and flower buds. **See label.**

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
LINER DIPS	To control plant height	Paclobutrazol	Paczol, Piccolo	0.5-8.0 ppm pre-plant liner dip (0.02-0.51 fl oz/gal)	**See label** for detailed recommendations for chemical application techniques, adjusting rates for northern or southern locations, and the specific rates for achieving the desired level of activity.
NEW GUINEA IMPATIENS	To control plant growth	Paclobutrazol	Bonzi, Paczol, Piccolo	0.25-15 ppm spray (0.01-0.48 fl oz/gal)	Apply 2-4 weeks after transplanting. Cultivars' response to PGRs varies greatly. Test a few plants to determine rate for optimal control.
				0.25-2.00 ppm drench (0.03-0.236 mg a.i.)	Drench volumes vary with pot size. See label for recommendations. Cultivars' response to PGRs varies greatly. Test a few plants to determine rate for optimal control.
		Ethephon	Florel	100-300 ppm spray (0.33-1 fl oz/gal)	To increase lateral branching and reduce premature flowering. Don't apply within 8 weeks of desired flower date.
		Fluprimidol	Topflor	5-15 ppm spray (0.167-0.5 fl oz/gal)	Apply 2-4 weeks after transplanting. Cultivars' response to PGRs varies greatly. Test a few plants to determine rate for optimal control.
OSTEOSPERMUM	To control plant growth	Daminozide + chlormequat chloride	B-Nine, Dazide + Citadel, Cycocel	1,500-3,000 ppm (0.24-0.47 oz/gal) + 1,000-1,500 ppm Cycocel (1.08-1.63 fl oz/gal) applied as a tank-mix spray	Multiple sprays required. Stop applications after visible bud to avoid flower delay and smaller flowers. Not effective in N.C. State University trials.
		Paclobutrazol	Bonzi, Paczol, Piccolo	27-54 ppm drench (8-16 mg a.i.) during production (based on N.C. State University trials)	Drench volumes vary with pot size. See label for recommended volumes.
				2-3 ppm drench (0.236-0.350 mg a.i.) for holding plants	
		Chlormequat chloride	Citadel, Cycocel	750-1,500 ppm spray (0.82-1.64 fl oz/gal)	Two applications may be required. Two applications of 1,500 ppm (with the first applied at the start and the second at the end of the vernalization period) provided excellent results in N.C. State University trials.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
OSTEO-SPERMUM (cont.)				1,500-3,000 ppm drench (1.63-3.26 fl oz/gal)	Drench volumes vary with pot size. See label for recommended volumes. 1,500 ppm worked well in N.C. State University trials.
		Uniconazole	Concise, Sumagic	3 ppm spray (1.86 fl oz/gal)	Recommendation based on European trials on a cultivar with prostrate growth. Rates less than 24 ppm were not effective in N.C. State University trials.
				0.25-2.00 ppm drench (0.06-0.47 fl oz/gal; apply 3 fl oz/5-inch pot).	One application of 1-2 ppm (at the start of vernalization) or two applications of 1 ppm (at the start of vernalization) and 0.5 ppm (at the end of the vernalizatioin period) provided excellent results in N.C. State University trials for 5-inch production.
		Paclobutrazol	Paczol, Piccolo	4-8 ppm liner root soak (0.128-0.256 fl oz/gal)	Irrigation of the liners occurred within 24 hours prior to application, which results in a moderately dry substrate (the stage the plants would be watered but not wilted). Soak for a minimum of 30-60 seconds. Transplant after 3-hour waiting period. Rated based on Michigan State University trials.
		Flurprimidol	Topflor	20-60 ppm spray (0.67-2 oz/gal)	
				1-2 ppm drench (0.017-0.067 fl oz/gal; apply 3 fl oz/5-inch pot).	One application of 1-2 ppm (at the start of vernalization) or two applications of 1 ppm (at the start of vernalization) and 0.5 ppm (at the end of the vernalizatioin period) provided excellent results in N.C. State University trials for 5-inch production.
PANSY	To control plant height	Ancymidol	Abide, A-Rest	3-15 ppm spray (1.5-7.3 fl oz/gal)	
		Paclobutrazol	Bonzi, Paczol, Piccolo	5-15 ppm spray (0.16-0.48 fl oz/gal)	Apply when plants are 2 inches in diameter. Use higher rates for higher temperatures and more vigorous cultivars. Late applications may delay flowering.
		Uniconazole	Concise, Sumagic	1-6 ppm spray (0.23-1.40 fl oz/gal)	Apply when plants are 3-4 inches tall. Use higher rates for higher temperatures and more vigorous cultivars. Late applications may delay flowering.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
PANSY (cont.)		Flurprimidol	Topflor	2.5-7.5 ppm spray (0.08-0.25 fl oz/gal)	Based on N.C. State University trials. Adjust rates for other locations. Pansies are very responsive to Topflor, so start trials with lower rates.
POINSETTIA	To control plant height	Ancymidol	Abide, A-Rest	0.06-0.25 mg a.i. (0.5-2.0 ppm) drench for a 6-inch pot (0.25-1 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drench volume and mg a.i. vary with pot size. Start with lower rates.
		Daminozide	B-Nine, Dazide	2,000-3,000 ppm spray (0.31-0.47 oz/gal)	Not effective in N.C. State University studies.
		Daminozide + chlormequat chloride	B-Nine, Dazide + Citadel, Cycocel	800-2,500 ppm (0.13-0.39 oz/gal) + 1,000-1,500 ppm chlormequat chloride (1.08-1.63 fl oz/gal) applied as a tank-mix spray	Use the higher rates of this tank-mix spray on stock plants and for finishing crops in very warm regions. Outside of very warm areas, use the lower rates. Late applications can delay flowering and reduce bract size.
		Paclobutrazol	Bonzi, Paczol, Piccolo	10-30 ppm spray (0.32-0.96 fl oz/gal)	Use higher rates of 15-45 ppm in southern Florida. Applications to slower-growing cultivars in cool climates should begin when axillary shoots are 2-3 inches long. For vigorous growing cultivars in warm climates, applications should begin when axillary shoots are 1.5-3.0 inches long. See label for other precautions.
		Paclobutrazol	Bonzi, Downsize, Paczol, Piccolo	0.237-0.473 mg a.i. (0.25-3.00 ppm) drench for a 6-inch pot (0.064-0.128 fl oz/gal of drench solution; apply 4 fl oz/6-inch pot).	Drenches generally have less of an effect on bract size than sprays. Drench volume and mg a.i. vary with pot size. Start with lower rates.
		Uniconazole	Concise	2.5-10.0 ppm spray (0.58-2.56 fl oz/gal)	Apply when the lateral shoots are 1.5-2.5 inches tall (about 10-14 days after pinching). Test for cultivar sensitivity. Multiple applications of the lower label rate may elicit a more satisfactory response. Do not apply after the initiation of short days. **For Florida only:** Use a foliar spray concentration between 10-15 ppm (2.5-3.8 fl oz/gal) and do not apply after Oct. 25.

Crop	Purpose	Chemical name	Trade name	Rate	Precautions and remarks
POINSETTIA (cont.)		Chlormequat chloride	Citadel, Cycocel	800-1,500 ppm spray (0.87-1.63 fl oz/gal)	For natural season crops in North Carolina, don't apply chlormequat chloride after mid-October to Nov. 1. Late applications can reduce bract size and delay flowering.
				3,000-4,000 ppm drench (3.25-4.34 fl oz/gal of drench solution)	Drench volume varies with pot size. Consult the label for recommended volumes.
		Uniconazole	Sumagic	2.5-10.0 ppm spray (0.58-2.33 fl oz/gal)	
		Flurprimidol	Topflor	2.5-80.0 ppm spray (0.08-2.69 fl oz/gal)	Use lower rates for less vigorous cultivars. **See label for additional rate recommendations.**
				0.03-0.50 mg a.i. (0.25-4.20 ppm) drench for a 6-inch pot	
	To promote plant growth	6-benzyladenine + gibberellins A_4A_7	Fascination	3 ppm spray (0.02 fl oz/gal)	Use an early season application during vegetative growth prior to the start of short days and flower initiation if promoting vegetative growth. **See label for additional precautions before use.**
		6-benzyladenine + gibberellins A_4A_7	Fascination, Fresco	3-10 ppm spray (0.02-0.07 fl oz/gal)	Use a late-season application to promote bract expansion. **See label for additional precautions before use.**

Notes:
1. ppm = parts per million
2. fl oz = fluid ounce(s)
3. gal = gallon(s)
4. sq ft = square feet
5. mg = milligrams
6. a.i. = active ingredient

PUBLICATION 430-102

www.ext.vt.edu

Produced by Communications and Marketing, College of Agriculture and Life Sciences,
Virginia Polytechnic Institute and State University, 2012

VT/0612/web/HORT-43P