Department of Horticultural Science

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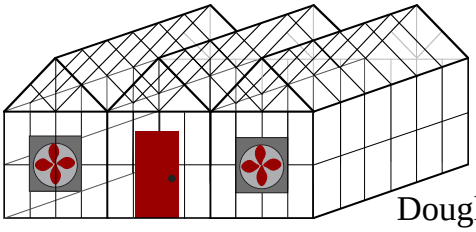

Height Control of Commercial Greenhouse Flowers

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Many greenhouse-grown floricultural crops tend to grow taller than desired and require height control measures to prevent excessive internodal elongation. This leaflet is designed to introduce commercial growers to the alternatives available for height control and suggest appropriate methods for different situations.

There are three categories of control available to producers—biological, physical, and chemical control. Each should be given consideration by producers who often produce undesirably tall crops.

When deciding on the best control method, consider the cost of the method (including equipment, labor, and other encountered expenses such as fuel); consider how the method will affect crop timing; and consider how the method will affect plant quality in the greenhouse, the retail outlet, and in its place of use.

Biological Control is theoretically the ultimate method. Through genetics and plant breeding, a plant cultivar is developed that grows to the perfect height. Often there are cultivars which are genetically short. For example, marigold cultivars can range in height from 5 to 30 inches. Select cultivars that best match your production system and market demands. Unfortunately, there are not perfect-height-cultivars for all of the greenhouse crops and growers must rely on other control mechanisms other than biological control of height.

Physical Control of plant height is based on knowing how the growing environment and cultural practices affect plant growth habits. Physical methods of control may include:

❶ **container size**—Size restriction of the root system can be used to slow the development/reduce the stretching of bedding plants. Ultimately, root zone restriction results in water stress and/or nutrient stress, discussed below.

❷ **water stress**—Allowing plants to wilt slightly between waterings leads to shorter plants, but quality may be greatly reduced. In some instances, such as with impatiens seedlings, it can be used quite effectively without long-term damage to the plants. Care should be taken not to subject plants to a wilt so severe that they cannot recover, or that leaf or flower damage occurs.

❸ **nutrient stress**—Withholding or reducing fertilizer tends to slow overall growth, including stem elongation. Reducing nitrogen fertilization to plants is effective in height control for some plants such as impatiens, but also slows down the growth and development of the plants along with stem elongation, and can reduce plant quality. Withholding phosporus application is a common practice to keep plug seedlings short.

❹ **wind, vibrations or touching**—Stem elongation is less when plants are exposed to wind, vibrations, or routine touching. These “seismomorphogenic” responses (responses to vibrations / wind) and “thigmomorphogenic” responses (responses to touching / brushing) can be used for height control, but are not economical in many cases and can spread

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foliar diseases. An exception would be with tomato and other vegetable transplants where there are no chemical height controls available. For example, brushing tomato transplants (foliage should be dry) for about 40 strokes back and forth with a cardboard tube suspended from an irrigation boom twice daily for 18 days can result in as much as a 30% reduction in stem elongation. This technique also works for Easter lilies, but again, the economics and labor requirements may be prohibitive and should be evaluated prior to implementation.

❺ **light intensity**—Higher light intensity or irradiance tends to reduce plant elongation, and plants will be shorter at maturity. The key wording is "shorter at maturity". Higher irradiance increases plant growth rate, and plants will grow faster at first than plants in lower irradiance. However, at maturity or flowering, the plants produced in higher light usually will be shorter. Given very poor light, plants tend to stretch, become leggy, and develop more slowly.

Placing plants too close together reduces the amount of light each plant receives and will result in excessive stretching as well. Use correct spacing of plants for best growth and reduced elongation.

❻ **photoperiod**—In general, short days of winter will result in both less growth and less height than long days of summer. The reduced growth is due to less light being received per day by the plants while the reduced elongation is a direct photoperiod response related to the daylength, not associated with lower irradiance levels. However, photoperiod is not a factor usually regulated strictly for height control since other effects such as flowering can also be affected by photoperiod.

❼ **light quality**—Recent research has documented that the high far red to red light ratio found during twilight and dawn is responsible for increased plant height. By drawing blackcloth over Easter lilies prior to twilight (about 30 minutes prior to standard sunset) and leaving plants covered until full sunrise (about 30 minutes after standard sunrise), a 20% reduction in height can be achieved. Other crops are probably also affected by eliminating twilight and dawn light. Another aspect of light quality that can be utilized to prevent excessive plant height is filtration of the longer (far red) wavelengths. Certain blue filters and blue tinted plastic greenhouse coverings can be effective in reducing internode elongation by changing the quality of light (filtering out certain wavelengths) plants receive.

❽ **temperature**—There are two main aspects of temperature that can affect plant growth and height. The average (average of day plus night) temperature affects plant growth rate; higher averages usually result in more rapid growth and development. The difference between the day and night temperature (DIF) affects stem elongation and plant height. The DIF is calculated as: day temperature (°F) minus night temperature (°F) and can be positive (day higher than night), zero (day = night), or negative (day less than night). Negative DIF's reduce stem elongation, compared to zero and positive DIF's and can be used to control plant height. Lowering the temperature for a 2 hour period starting 30 minutes prior to dawn is almost as effective as keeping a lower temperature throughout the entire day. This is fortunate for growers in North Carolina, since temperatures during most of the year prohibit maintaining a 60 °F day temperature for the entire day. DIF is effective on many crops including many bedding plants, poinsettias, mums, and Easter lilies (Table 1).

A suggested DIF program for many plants such as poinsettias and most bedding plants would be to use a 68 °F night temperature, a 2 hour drop to 60 °F beginning 30 minutes prior to dawn, and a 65 °F day venting temperature setting. For warm-grown plants including begonia, vinca, and verbena, use a 72 °F night temperature, a 64 °F 2 hour drop beginning 30 minutes prior to dawn, and a 65 °F day venting temperature setting. Be aware that night temperatures above 68 °F can cause delay in floral initiation of some crops such as poinsettias; these night temperatures are best avoided, except when recommended for specific crops. Also a delay in flowering may occur if

average daily temperature (average of day + night temperature) is reduced below about 62 °F; lower daily averages slow growth and development rates. Too great a negative DIF (greater than minus 10 °F) should not be used; it can cause leaves to droop and appear wilted.

Another concern with DIF is timing of the application with respect to flower development. Do not use DIF late in the cropping cycle or flower and bract size can be reduced. For example, DIF should be discontinued on a poinsettia crop prior to visible bract color.

Chemical Control involves the use of chemical growth retardants. Most of the available growth retardants are anti-gibberellins, as they inhibit gibberellin (GA) synthesis within the plant. GA's are responsible for cellular elongation, so without them cells do not elongate as much, and plants do not grow as tall. Ethephon (Florel®) is not an anti-gibberellin. Ethephon releases ethylene, which reduces elongation in some bulb crops.

The chemical growth retardants labeled for use in floriculture differ in their basic characteristics and affect growers' choices of chemicals as well as determine when and how to apply (Table 2). Specific recommendations for floricultural crops that are in compliance with the product labels are given in Table 3. Notice that most labels give a broad range of rates for each crop. Consult with floricultural specialists at N.C. State University for more specific rates prior to using a new growth retardant treatment.

As the chemicals used become more effective and expensive, it becomes increasingly important to apply growth retardants in the most efficient manner possible. With chemical growth retardants always consider timing, target tissue, dosage, and application technique.

Timing: For most plants, apply after the plant has developed sufficient foliage (photosynthetic area, leaf area) to prevent stunting of the plant's development. An example appears on the Sumagic® label, recommending a minimum height of 4 inches for pansies prior to a spray application. Apply just prior to rapid shoot elongation; e.g. after pinching and newly developing shoots are visible, but have not yet elongated. Make your final application before the stage when floral size will be reduced. If growth retardants are applied too late, the size of the flowers can be reduced and floral development can be slowed. A good example would be bract size reduction in poinsettia due to late application of Cycocel® or Bonzi®. Remember that timing of application should be based on a physiological stage of plant development such as number of leaves, length of shoots, or plant diameter, not chronological age such as 3 weeks after pinching.

Table 1. Plant response to DIF.*

Common name	Response to DIF**
African daisy	2
Ageratum	3
Alyssum	1
Aster	3
Astilbe	2
Baby's breath	3
Basil	3
Bean	0
Begonia (fibrous)	1
Begonia (tuberous)	1
Broccoli	3
Browalia	2
Brussel sprouts	3
Cabbage	3
Calendula	2
Campanula	3
Cataloupe	3
Cauliflower	3
Celosia	2
Chrysanthemum	3
Cleome	2
Coleus	2
Columbine	2
Cosmos	2
Cucumber	1-2
Dahlia	3
Dianthus	3
Dusty miller	1
Easter lily	3
Eggplant	3
Geranium	2
Gerbera daisy	1
Gomphrena	2
Hibiscus	1
Impatiens	2
Lobelia	1
Marigold (African)	1
Marigold (French)	0
Morning glory	3
Moss rose	2
New Guinea impatiens	1
Pansy	2

Table 1, continued. Plant response to DIF.*

Common name	Response to DIF**
Pea	0-1
Pepper	0-1
Petunia	1-2
Poinsettia	3
Salvia	2-3
Snapdragon	1
Squash	2
Verbena	1-2
Vinca	1-2
Watermelon	3

*Adapted from: J.E. Erwin and R.D. Heins. 1993. Temperature effects on bedding plant growth. Minnesota Commercial Flower Growers Bulletin 42(1):1–18.
**Response is indicated on a scale of 0 to 3, where 0 indicates no response and 3 indicates a strong response.

Recommendations given in terms of chronological age are merely guidelines that have been correlated to physiological stages and should only be used as rough estimates as to when to apply growth retardants.

Target: The target tissue or plant part to receive the chemical depends on the chemical used and the plant species being grown.

Foliage and Stems: Chemicals can be sprayed on, or shoots can be dipped into the solution at time of transplanting. If dipping shoots into a solution, use a consistent soaking time, say 10 seconds. For sprays, remember that areas are sprayed, not individual plants. This is the only way to assure even coverage and consistent results. If growers "spray to runoff" or "spray to glistening", every grower will apply a different amount, and there is no way of predicting the results.

Substrate: Apply to the substrate (growth media or soil). This is the same as a soil drench; drenches use larger volumes

(Text continued on page 15)

Table 2. Growth regulators labeled for height control of greenhouse florists crops.*

Trade name/ Common name	Comments
A-Rest Ancymidol	Greater activity on most crops than B-Nine or Cycocel; not as difficult to apply as Bonzi or Sumagic; duration of growth regulating activity is greater than B-Nine and Cycocel but less than Bonzi and Sumagic; effective as a spray or drench.
B-Nine Daminozide	Least active and has least residual effect of growth retardants listed, but is the easiest to use; activity is decreased by high temperatures; effective only as a spray (no drench effect); do not wet the shoots of treated plants for 24 hours post-spray, or else the chemical activity will be reduced.
Bonzi Paclobutrazol	Very active and persistent growth retardant; avoid overapplication and spray drift onto non-target species; only phytotoxicity reported is on vinca under high temperatures; has broad spectrum label for use on most any floricultural crop in the greenhouse; active on most species; effective as a spray or a drench; sprays are not translocated out of foliage, so activity originates from stem coverage and drenching effect from spray that enters the substrate.
Cycocel Chlormequat-chloride	Is active on and labeled for only a very few crops, including geraniums and poinsettias; foliar injury (yellow spots on leaves) can occur with spray applications >1,500 ppm; has less persistence and activity than Bonzi and Sumagic; is effective as a spray or drench, but effective drench rates are cost-prohibitive.
Florel Ethephon	Effective on and labeled as a growth retardant for only a very few crops, including daffodil and hyacinth; effective only as a spray.
Sumagic Uniconazole	Most active and persistent growth retardant listed; avoid overapplication and spray drift onto non-target species; no phytotoxicity reported, but as with Bonzi, overapplication can lead to stunting; active on most species; effective as a spray or a drench; sprays are not translocated out of foliage, so activity originates from stem coverage and drenching effect from spray that enters the substrate.

*This table only includes plant growth regulators labeled for height control purposes (used as a plant growth retardant) and not other purposes such as branching stimulation (Atrimmec and Florel), stimulation of elongation (Pro-Gibb), delay of flowering in garden mums (Florel), and floral initiation of bromeliads (Florel) and azaleas (B-Nine).

Table 3. Labeled rates for chemical plant growth retardants.

Crop	Product	Application Method & Rate	Precautions & Remarks
Ageratum	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	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 gallon per 100 square feet of bench area. Growers should refer to Horticulture Information Leaflet #528, Height Control of Greenhouse Crops, for application techniques and timing for growth regulators on floricultural crops. Contact floricultural specialists at NC State University for further application information.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	5 to 45 ppm spray (0.16 to 1.44 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	20 to 30 ppm spray (5.12 to 7.68 fl oz/gal)	
Alternanthera (Joseph's-Coat)	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Alyssum	Sumagic	5 to 25 ppm spray (1.3 to 6.4 fl oz/gal)	See Ageratum.
Amaryllis	Bonzi	23.66 mg a.i. drench for a 6 inch pot (6.4 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Aster	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Azalea	A-Rest	26 ppm spray (12.6 fl oz/gal)	Contact floricultural specialists at NC State University.
	Bonzi	100 to 200 ppm spray (3.2 to 6.4 fl oz/gal)	To control plant height and promote flower bud initiation, apply after final shaping, when new growth is 1.5 to 2 inches long. To reduce bypass shoot development, apply after bud set, when bypass shoots are barely visible.
		0.59 to 1.77 mg a.i. drench for a 6 inch pot (0.16 to 0.48 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Sumagic	10 to 15 ppm spray (2.56 to 3.84 fl oz/gal)	Apply at 1.5 quarts per 100 square feet of bench area. Contact floricultural specialists at NC State University for further application information.
Bedding Plants (Not specifically listed in this table)	A-Rest	6 to 66 ppm spray (2.9 to 32 fl oz/gal). Use 15 ppm spray as a base rate and adjust as needed.	See Ageratum.
		0.06 to 0.12 mg a.i. drench for a 4 inch pot (0.5 to 1 fl oz/gal of drench solution; apply 2 fl oz/4 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine + Cycocel	800 to 5,000 ppm B-Nine (0.13 to 0.79 oz/gal) + 1,000 to 1,500 ppm Cycocel (1.08 to 1.63 fl oz/gal) applied as a tank mix spray	It is recommended to use the highest rate of Cycocel that does not cause excessive leaf yellowing, and then adjust the B-Nine rate up and down within the labeled range to attain desired level of height control.
	Bonzi	30 ppm spray (0.96 fl oz/gal)	Users should 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.
		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.
	Cycocel	800 to 3,000 ppm spray (0.87 to 3.25 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control.
	Sumagic	1 to 50 ppm spray (0.26 to 12.7 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Bedding Plant Plugs (Not specifically listed in this table)	A-Rest	3 to 35 ppm spray (1.5 to 17 fl oz/gal)	See Ageratum.
		Drench plug flats with a 0.5 to 1 ppm solution (0.25 to 1 fl oz/gal)	For uniform application, use a subirrigation delivery system. Plug trays should not be excessively dry prior to the subirrigation treatment.
	B-Nine	1,500 to 2,500 ppm spray (0.23 to 0.39 oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and duration of height control. Can be used at the beginning of the first true leaf stage through the finishing stage.
	B-Nine + Cycocel	800 to 5,000 ppm B-Nine (0.13 to 0.79 oz/gal) + 1,000 to 1,500 ppm Cycocel (1.08 to 1.63 fl oz/gal) applied as a tank mix spray	It is recommended to use the highest rate of Cycocel that does not cause excessive leaf yellowing, and then adjust the B-Nine rate up and down within the labeled range to attain desired level of height control.
	Bonzi	5 ppm spray (0.16 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and duration of height control. Plants should develop 1 to 2 true leaves prior to first application.
	Cycocel	400 to 1,500 ppm spray (0.43 to 1.63 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rates as needed for desired final plant height and duration of height control.
	Sumagic	0.5 to 10 ppm spray (0.13 to 2.6 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and duration of height control. Plugs can be especially sensitive to Sumagic.
Begonia	A-Rest	3 to 15 ppm spray (1.5 to 7.3 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
Bleeding Heart	A-Rest	65 to 132 ppm spray (31.5 to 64 fl oz/gal	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Browallia	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Bulb Crops (Not specifically listed in this table)	A-Rest	25 to 50 ppm spray (12.1 to 24.2 fl oz/gal)	Drenches are more effective than sprays.
		0.25 mg a.i. drench for a 6 inch pot (2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.
	Bonzi	100 ppm spray (3.2 fl oz/gal)	
		1.183 mg a.i. drench for a 6 inch pot (0.32 fl oz/gal of drench solution; apply 4 fl oz per 6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
		20 ppm bulb soak (0.64 fl oz/gal)	Soak for 15 minutes. Users should conduct trials on a small number of bulbs, adjusting the rate and soaking period (up to 1 hour) as needed for desired final plant height.
	Sumagic	2.5 to 20 ppm spray (0.64 to 5.1 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.
		1 to 3 ppm drench (0.26 to 0.8 fl oz/gal)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
		1 to 10 ppm bulb soak (0.26 to 2.6 fl oz/gal)	Soak for 1 to 5 minutes. Users should conduct trials on a small number of bulbs, adjusting the rate and soaking period as needed for desired final plant height.
Caladium	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
	Bonzi	100 to 200 ppm spray (3.2 to 6.4 fl oz/gal)	First spray applications should be made when plants are 2 to 4 inches tall.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Caladium, continued		1.183 to 2.366 mg a.i. drench for a 6 inch pot (0.32 to 0.64 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	First drench applications should be made when plants are 1 to 2 inches tall. Drench volumes and mg a.i. vary with pot size.
Calla Lily	Bonzi	1.183 to 3.549 mg a.i. drench for a 6 inch pot (0.32 to 0.96 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	See Caladium.
		20 ppm rhizome/tuber soak (0.64 fl oz/gal)	Soak the rhizomes/tubers for 15 minutes prior to planting.
Celosia	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	4 to 50 ppm spray (0.13 to 1.60 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	10 to 20 ppm spray (2.56 to 5.12 fl oz/gal)	
China Aster	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	
Chrysanthemum, Cut	B-Nine	2,500 ppm spray (0.39 oz/gal)	Spray upper foliage 5 weeks after start of short-day treatment.
Chrysanthemum, Potted	A-Rest	25 to 50 ppm spray (12.1 to 24.2 fl oz/gal)	Contact floricultural specialists at NC State University.
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	1,000 ppm preplant foliar dip (0.16 oz/gal)	Contact floricultural specialists at NC State University.
		1,250 to 5,000 ppm spray (0.20 to 0.79 oz/gal)	Spray when new growth from pinch is 1 to 2 inches long. Some varieties may require another application 3 weeks later.
	Bonzi	50 to 200 ppm spray (1.6 to 6.4 fl oz/gal)	Contact floricultural specialists at NC State University.
		0.118 to 0.473 mg a.i. drench for a 6 inch pot (0.032 to 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. Contact floricultural specialists at NC State University.
	Sumagic	2.5 to 10 ppm spray (0.64 to 2.56 fl oz/gal)	Contact floricultural specialists at NC State University.
Chrysanthemum, Garden	Sumagic	2.5 to 10 ppm spray (0.64 to 2.56 fl oz/gal)	Contact floricultural specialists at NC State University.
Clematis	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Cleome	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
Coleus	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Coleus, continued	Bonzi	5 to 45 ppm spray (0.16 to 1.44 fl oz/gal)	See Ageratum.
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	10 to 20 ppm spray (2.56 to 5.12 fl oz/gal)	
Columbine	A-Rest	65 to 132 ppm spray (31.5 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Cone flower	Sumagic	30 to 40 ppm spray (7.7 to 10.2 fl oz/gal)	
Cornflower (*Centaurea*)	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
Cosmos	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Crossandra	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Daffodil	Bonzi	2.366 to 4.732 mg a.i. drench for a 6 inch pot (0.64 to 1.28 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	See Caladium
	Florel	1,000 to 2,000 ppm spray (3.24 to 6.47 fl oz/gal)	Contact floricultural specialists at NC State University.
Dahlia, Bedding Plant	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	5 to 45 ppm spray (0.16 to 1.44 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	10 to 20 ppm spray (2.56 to 5.12 fl oz/gal)	
Dahlia, Tuberous	A-Rest	0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Bonzi	1.183 to 4.732 mg a.i. drench for a 6 inch pot (0.32 to 1.28 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	
Delphinum	A-Rest	35 to 132 ppm spray (17 to 64 fl oz/gal)	See Ageratum.
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Dianthus	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Dianthus, continued	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
	Bonzi	5 to 60 ppm spray (0.16 to 1.92 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
Dracaena	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Dusty Miller	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
	Sumagic	30 ppm spray (7.7 fl oz/gal)	
Easter Lily	A-Rest	50 ppm spray (24.2 fl oz/gal)	Contact floricultural specialists at NC State University.
		0.25 to 0.5 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Sumagic	10 to 25 ppm spray (2.56 to 6.4 fl oz/gal)	Contact floricultural specialists at NC State University.
		0.03 to 0.06 mg a.i. drench for a 6 inch pot (0.065 to 0.13 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Exacum	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
Fatshedera	A-Rest	65 to 132 ppm spray (31.5 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Flowering/Foliage Plants, Herbaceous Species (Not specifically listed in this table)	A-Rest	20 to 50 ppm spray (9.7 to 24.2 fl oz/gal)	Recommended starting rate for an A-Rest spray on a new herbaceous flowering or foliage species is 33 ppm (16 fl oz/gal).
		0.125 to 0.25 mg a.i. drench for a 6 inch pot (0.5 to 1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Bonzi	30 ppm spray (0.96 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.
		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 volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Cycocel	800 to 4,000 ppm spray (0.87 to 4.34 fl oz/gal)	Optimum rate depends on species, desired amount of height control, and environmental conditions. The suggested initial rate for small-scale trials is 1,250 ppm. Example herbaceous species known to respond to cycocel are Achimenes, Aster, Astilbe, Begonia (hiemalis), Begonia (tuberous), Calceolaria, Carnation, Chrysanthemum, Columbine, Easter lily, *Gynura aurantiaca*, Ivy, Kalanchoe, *Lilium* spp., Morning glory, Pachystachys, *Pilea* spp., Pentas, *Salvia* spp., Schefflera, *Sedum* spp., and Sunflower.
		2,000 to 4,000 ppm drench	Drench volumes vary with pot size. See label for recommended volumes. Herbaceous species known to respond to cycocel are listed above.
	Sumagic	5 to 40 ppm spray (1.3 to 10.2 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Flowering/Foliage Plants, Herbaceous Species, Continued	Sumagic	0.1 to 1 ppm drench (0.026 to 0.26 fl oz/gal)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Flowering/Foliage Plants, Woody Species (Not specifically listed in this table)	A-Rest	50 ppm spray (24.2 fl oz/gal)	
		0.25 mg a.i. drench for a 6 inch pot (1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	2,500 to 7,500 ppm spray (0.39 to 1.18 oz/gal)	Two or more applications may be necessary if new growth begins to stretch or for enhanced coloration.
	Bonzi	50 ppm spray (1.6 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.
		0.237 mg a.i. drench for a 6 inch pot (0.064 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Cycocel	800 to 4,000 ppm spray (0.87 to 4.34 fl oz/gal)	Optimum rate depends on species, desired amount of height control, and environmental conditions. The suggested initial rate for small-scale trials is 1,250 ppm. Example woody species known to respond to cycocel are *Baleria cristata*, Bougainvillea, Camellia, Gardenia, Fuchsia, Hollies, Hydrangea, Lantana, *Pseuderanthemum lactifolia*, Rhododendron, and Roses (potted).
		2,000 to 4,000 ppm drench	Drench volumes vary with pot size. See label for recommended volumes. Woody species known to respond to cycocel are listed above.
	Sumagic	20 to 50 ppm spray (5.1 to 12.7 fl oz/gal)	Users should conduct trials on a small number of plants, adjusting the rate as needed for desired final plant height and length of height control.
		0.5 to 2 ppm drench (0.13 to 0.52 fl oz/gal)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Freesia	Bonzi	100 to 300 ppm corm soak (3.2 to 9.6 fl oz/gal)	Soak corms in the solution for 1 hour before planting.
Gardenia	A-Rest	50 ppm spray (24.2 fl oz/gal)	
		0.25 mg a.i. drench for a 6 inch pot (1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	5,000 ppm spray (0.79 oz/gal)	
Geranium	A-Rest	26 to 66 ppm spray (12.6 to 32 fl oz/gal)	See Ageratum.
	Bonzi	5 to 20 ppm spray (0.16 to 0.64 fl oz/gal)	Apply to zonal geraniums when new growth is 1.5 to 2 inches long. Apply to seed geraniums approximately 2 to 4 weeks after transplanting.
	Cycocel	800 to 1,500 ppm spray (0.87 to 1.63 fl oz/gal)	First application should be made 2 to 4 weeks after planting plugs or rooted cuttings (after stems have started elongating). Multiple applications may be needed.
	Sumagic	3 to 6 ppm spray (0.77 to 1.54 fl oz/gal) for cutting geraniums and 2 to 4 ppm spray (0.51 to 1.02 fl oz/gal) for seed geraniums	See Ageratum.
Gerbera Daisy	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	1,200 to 5,000 ppm spray (0.18 to 0.79 oz/gal)	
Gloxinia	B-Nine	1,250 ppm spray (0.19 oz/gal)	Phytotoxicity may occur at rates >1,250 ppm.
Gomphrena	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Gomphrena, continued	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	See Ageratum.
Hibiscus	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	30 to 150 ppm spray (0.96 to 4.8 fl oz/gal)	Application should be made when laterals are 1 to 4 inches long. Single applications control lateral growth for 3 to 6 months.
	Cycocel	200 to 600 ppm spray (0.22 to 0.65 fl oz/gal)	Multiple applications starting prior to first pinch are recommended. Start with 460 ppm in trials.
Holly	A-Rest	50 ppm spray (24.2 fl oz/gal)	
		0.25 mg a.i. drench for a 6 inch pot (1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Hollyhock	Sumagic	5 to 40 ppm spray (1.3 to 10.2 fl oz/gal)	
Hyacinth	Florel	1,000 ppm spray (3.24 fl oz/gal)	Contact floricultural specialists at NC State University.
Hybrid Lily	Bonzi	250 to 500 ppm spray (8.0 to 16.0 fl oz/gal)	See Caladium.
		1.183 to 2.366 mg a.i. drench for a 6 inch pot (0.32 to 0.64 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	
	Bonzi	20 to 30 ppm bulb soak (0.64 to 0.96 fl oz/gal)	Soak bulbs in the solution for 15 minutes prior to planting.
	Sumagic	2.5 to 10 ppm spray (0.6 to 2.6 fl oz/gal)	
		1 to 10 ppm bulb soak (0.26 to 2.6 fl oz/gal)	Soak bulbs in the solution for 1 to 5 minutes prior to planting.
Hydrangea	A-Rest	50 ppm spray (24.2 fl oz/gal)	
		0.25 mg a.i. drench for a 6 inch pot (1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	2,500 to 7,500 ppm spray (0.39 to 1.18 oz/gal)	Contact floricultural specialists at NC State University.
Hypoestes	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	See Ageratum.
Impatiens	A-Rest	10 to 44 ppm spray (4.8 to 21.3 fl oz/gal)	See Ageratum.
	Bonzi	5 to 45 ppm spray (1.44 to 2.02 fl oz/gal)	
	Sumagic	5 to 10 ppm spray (1.28 to 2.56 fl oz/gal)	
Jerusalem Cherry	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	See Ageratum.
Kalanchoe	B-Nine	1,200 to 5,000 ppm spray (0.18 to 0.79 oz/gal)	Phytotoxicity possible if B-Nine accumulates in cupped areas of certain cupped-leafed varieties.
Liatris	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	

Crop	Product	Application Method & Rate	Precautions & Remarks
Marigold	A-Rest	13 to 33 ppm spray (6.3 to 16 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	10 to 60 ppm spray (0.32 to 1.92 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	10 to 20 ppm spray (2.56 to 5.12 fl oz/gal)	
Monarda	Sumagic	15 to 30 ppm spray (3.8 to 7.7 fl oz/gal)	
Monstera	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Montbretia	Bonzi	20 to 30 ppm corm soak (0.64 to 0.96 fl oz/gal)	Soak corms in the solution for 15 minutes prior to planting.
Nasturtium	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
Nepthytis, Green & Green Gold	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Pansy	A-Rest	3 to 15 ppm spray (1.5 to 7.3 fl oz/gal)	See Ageratum.
	Bonzi	1 to 15 ppm spray (0.03 to 0.48 fl oz/gal)	
	Sumagic	1 to 6 ppm spray (0.26 to 1.54 fl oz/gal)	
Petunia	A-Rest	10 to 26 ppm spray (4.8 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	5 to 60 ppm spray (0.16 to 1.92 fl oz/gal)	
	Sumagic	25 to 50 ppm spray (6.4 to 12.79 fl oz/gal)	
Philodendron	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Phlox	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
Pilea	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Poinsettia	A-Rest	0.06 to 0.25 mg a.i. drench for a 6 inch pot (0.25 to 1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Contact floricultural specialists at NC State University.
	B-Nine	2,000 to 3,000 ppm spray (0.31 to 0.47 oz/gal)	Not effective in our studies.
	B-Nine + Cycocel	800 to 2,500 ppm B-Nine (0.13 to 0.39 oz/gal) + 1,000 to 1,500 ppm Cycocel (1.08 to 1.63 fl oz/gal) 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, growers should use the lower rates. Too late of an application can delay flowering and reduce bract size.
	Bonzi	10 to 30 ppm spray (0.32 to 0.96 fl oz/gal)	Contact floricultural specialists at NC State University.
		0.237 to 0.473 mg a.i. drench for a 6 inch pot (0.064 to 0.128 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volume and mg a.i. vary with pot size. Consult the label for recommended volumes.
	Cycocel	800 to 1,500 ppm spray (0.87 to 1.63 fl oz/gal)	For natural season crops in N.C., do not apply cycocel after Nov. 1. Late applications can reduce bract size and delay flowering.
		3,000 to 4,000 ppm drench (3.25 to 4.34 fl oz/gal of drench solution)	Drench volume varies with pot size. Consult the label for recommended volumes.
	Sumagic	2.5 to 10 ppm spray (0.64 to 2.56 fl oz/gal)	Contact floricultural specialists at NC State University.
Portulaca	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum
	Sumagic	15 to 30 ppm spray (3.8 to 7.7 fl oz/gal)	
Pothos	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Purple Cone flower	Sumagic	30 to 40 ppm spray (7.7 to 10.2 fl oz/gal)	
Purple Passion (*Gynura aurantiaca*)	A-Rest	26 to 132 ppm spray (12.6 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
Salvia	A-Rest	10 to 26 ppm spray (4.8 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	5 to 60 ppm spray (0.16 to 1.92 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	5 to 10 ppm spray (1.28 to 2.56 fl oz/gal)	
Schefflera	A-Rest	25 to 132 ppm spray (12.1 to 64 fl oz/gal)	
		0.25 to 0.50 mg a.i. drench for a 6 inch pot (1 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.

Table 3. Continued.

Crop	Product	Application Method & Rate	Precautions & Remarks
Shasta Daisy	Sumagic	15 to 30 ppm spray (3.8 to 7.7 fl oz/gal)	
Snapdragon	A-Rest	10 to 26 ppm spray (4.8 to 12.6 fl oz/gal)	See Ageratum.
	Bonzi	5 to 90 ppm spray (0.16 to 2.88 fl oz/gal)	
	Sumagic	25 to 50 ppm spray (6.4 to 12.79 fl oz/gal)	
Speedwell (Veronica)	Sumagic	20 to 40 ppm spray (5.1 to 10.2 fl oz/gal)	
Sunflower	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
Tulip	A-Rest	0.125 to 0.5 mg a.i. drench for a 6 inch pot (0.5 to 2 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Bonzi	0.591 to 4.732 mg a.i. drench for a 6 inch pot (0.16 to 1.28 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size.
		2 to 5 ppm bulb soak (0.064 to 0.16 fl oz/gal)	Soak bulbs for 1 hour prior to planting.
Verbena	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	See Ageratum.
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
Vinca (*Catharanthus*)	A-Rest	5 to 18 ppm spray (2.4 to 8.7 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	
	Sumagic	1 to 3 ppm spray (0.26 to 0.77 fl oz/gal)	
Viola	Sumagic	1 to 5 ppm spray (0.26 to 1.28 fl oz/gal)	See Ageratum.
Wandering Jew	A-Rest	26 to 132 ppm spray (12.6 to 64 fl oz/gal)	
Woody Landscape Plants (Not specifically listed in this table)	A-Rest	50 ppm spray (24.2 fl oz/gal)	
		0.25 mg a.i. drench for a 6 inch pot (1 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	Drench volumes and mg a.i. vary with pot size. Contact floricultural specialists at NC State University.
	Bonzi	0.473 mg a.i. drench for a 6 inch pot (0.128 fl oz/gal of drench solution; apply 4 fl oz/6 inch pot)	See Bedding Plants
		100 ppm spray (3.2 fl oz/gal)	
Zinnia	A-Rest	7 to 26 ppm spray (3.4 to 12.6 fl oz/gal)	See Ageratum.
	B-Nine	2,500 to 5,000 ppm spray (0.39 to 0.79 oz/gal)	
	Bonzi	5 to 45 ppm spray (0.16 to 1.45 fl oz/gal)	
	Cycocel	400 to 3,000 ppm spray (0.43 to 3.25 fl oz/gal)	

(Text continued from page 4)

of solution per plant/pot, but usually at lower concentrations than a spray or dip. Drenches can take more time to apply than sprays, and require exact metering of volume delivered per pot. There are machines available that automatically deliver exact volumes to automate drenching procedures.

Roots: Apply directly to the roots / underground portion of the plant. This method is restricted to plants such as dahlia tubers that are potted by the grower. Growth retardants can be applied as a dip or soak in solution to roots, bulbs, corms, tubers, or crowns. An example is a Bonzi® dip, which is labeled as a preplant soak for amaryllis, caladiums, calla lily, daffodil, freesias, hybrid lily, montbretia, tulips, and other bulb species. One major problem with bulb soaks noted in research with Easter lilies has been inconsistent results and high plant-to-plant variability in response.

Dosage: Read the label; do not guess on dosage. Keep in mind that a dosage is the product of [concentration of solution applied] × [volume of solution applied]. If either are incorrect, results could be unpredictable, un-repeatable, and unacceptable.

Application Technique: As with the target tissue, the method of delivering the growth retardant depends on both the chemical used and the plant species to be treated.

Dips: With some plants it is possible to dip the plant shoot, or underground portion (bulb, corm) into a growth retardant solution prior to potting. This method is labeled and is very effective for applying B-Nine® to the shoots of rooted chrysanthemums just prior to potting. This is fairly accurate, if each plant remains in the solution for the same amount of time, and if each plant has approximately the same size shoot/ bulb. Unfortunately, this method is not feasible with many of the crops grown, and dipping plants in a common solution could result in the spread of disease organisms.

Drenches: Applying a growth retardant in a drench form is fairly easy. Measure out a known amount of chemical, add it to a known volume of water, and apply a known volume of the drench to each pot / plant. Do not apply any plant growth regulator through an irrigation system, unless the label lists chmigation as a legal application technique. Currently, it is legal to apply A-Rest® through drip, overhead boom, sprinkler, and flood (subirrigation) systems. Consult the label for specific application recommendations.

Sprays: Spray applications can be more difficult to apply evenly. Some chemical labels recommend to "spray to runoff"; that is, spray each plant until spray visibly just begins to drip off of the foliage. Depending on the size of the plant, the sprayer's objectivity, and other factors, varying amounts of chemical will be applied to each plant. It is much safer and more accurate to base spray application on areas, not plants. What does that mean? Apply a known volume of spray to a known area (square footage), regardless of how many plants are in that known area. The general recommendation is to apply $^1/_2$ gallon per 100 ft^2. This volume is sufficient to comfortably walk 25 feet while spraying a 4 foot-wide bench, thus the basis for the recommendation. If the area is sprayed evenly, it assures that each pot will receive the same amount of spray (the amount is easy to calculate, too), regardless of how many containers are in the area. Unless growers measure out the spray applied to each pot (or calibrate your output rate and time the spray for each pot while maintaining a constant tank pressure), there is no other way to evenly apply the spray over your plants.

When addressing height control in greenhouse crops, remember to evaluate all available possibilities and to base decisions on cost, quality, and best management practices. If chemical control is the most feasible choice, make applications correctly and accurately. Chemical costs (based on product costs at time of publication) of spray and drench applications are given in Table 4. Uniformity and consistency are crucial to attain predictable and desirable results. Also remember that growth regulators are regarded as pesticides and that it is a violation of Federal and State Law to use these products in a manner inconsistent with their labels.

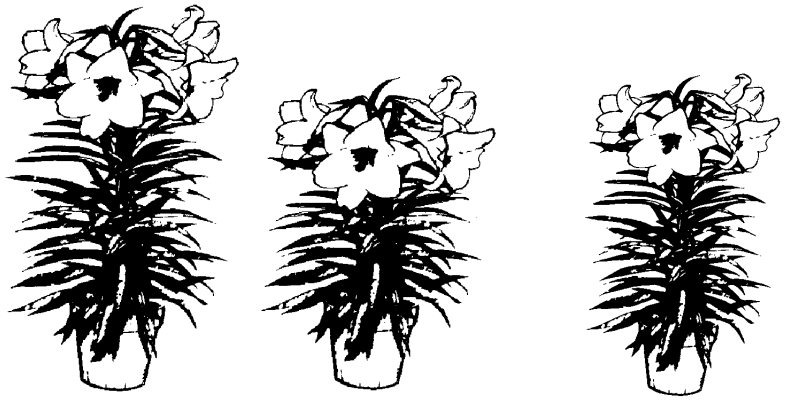
Table 4. Chemical costs for growth retardant sprays and drenches.

Chemical and cost[Z]	Spray applications			Drench applications			
	Conc. applied (ppm)	Amount of chemical needed for 10 gallons of spray[Y]	Cost per 100 ft² of bench area sprayed[X]	Milligrams of active ingredient per 6 inch pot	Conc. applied (ppm)	Fluid oz. of chemical needed for 10 gallons of drench solution	Cost per 100 six inch pots
A-Rest $64 per quart	2	9.7 fl oz.	$0.97	0.125	1.1	5.12	$3.13
	5	24.2 fl oz.	$2.42	0.25	2.1	10.25	$6.40
	10	48.5 fl oz.	$4.85	0.375	3.2	15.37	$9.61
	26	4 quarts	$12.61	0.50	4.2	20.49	$12.81
	33	5 quarts	$16.00	**NOTE:** A-Rest drench figures are based on applying 4 fluid oz. of drench per 6 inch pot.			
	66	10 quarts	$32.00				
	132	20 quarts	$64.00				
B-Nine $342 per 5 pounds	750	1.18 oz.	$0.25				
	2,500	3.93 oz.	$0.84				
	5,000	7.85 oz.	$1.68				
Bonzi $109 per quart	2	0.64 fl oz.	$0.11	0.1183	1	0.32	$0.34
	5	1.60 fl oz.	$0.27	0.2366	2	0.64	$0.68
	10	3.20 fl oz.	$0.55	0.4732	4	1.28	$1.36
	20	6.40 fl oz.	$1.09	0.5915	5	1.60	$1.70
	30	9.60 fl oz.	$1.64	1.1835	10	3.20	$3.41
	45	14.40 fl oz.	$2.45	1.7744	15	4.80	$5.11
	60	19.20 fl oz.	$3.27	2.3659	20	6.40	$6.81
				NOTE: Bonzi drench figures are based on applying 4 fluid oz. of drench per 6 inch pot.			
Cycocel $71 per quart	750	8.14 fl oz.	$0.90	354.88	2,000	21.7	$22.56
	1,500	16.27 fl oz.	$1.81	532.32	3,000	32.5	$33.85
	2,000	21.69 fl oz.	$2.41	709.76	4,000	43.4	$45.13
				NOTE: Cycocel drench figures are based on applying 6 fluid oz. of drench per 6 inch pot.			
Florel $22.50 per quart	500	16.19 fl oz.	$0.57				
	1,000	32.37 fl oz.	$1.14				
	2,000	64.74 fl oz.	$2.28				
Sumagic $110 per quart	2	5.12 fl oz.	$0.80	0.03	0.25	0.65	$0.70
	5	12.80 fl oz.	$2.20	0.06	0.51	1.30	$1.39
	10	25.60 fl oz.	$4.40	**NOTE:** Sumagic drench figures are based on applying 4 fluid oz. of drench per 6 inch pot.			
	15	38.40 fl oz.	$6.60				
	20	51.20 fl oz.	$8.80				
	30	76.80 fl oz.	$13.20				

[Z]Costs were averaged from three sources. Price will vary with supplier and quantity ordered.

[Y]Assuming an application rate of 2 quarts per 100 ft², this amount of spray will treat 2,000 ft² of bench area.

[X]Assuming an application rate of 2 quarts per 100 ft² of bench area. The cost per pot or flat can be calculated by dividing the figures in this column by the number of pots or flats per 100 ft².



Suggested Readings

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