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CHEMICAL GROWTH RETARDANTS FOR BEDDING PLANTS

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Height control of floricultural crops is one of the many cultural tasks growers must face, especially during bedding plant production. Holiday crops have a firmly set market date, but bedding plants may have to be held for extended periods of time and growth must be controlled to maintain salable plants. Last September (N.C. Flower Growers' Bul. 35(5):10-13), height control of greenhouse crops was discussed, and Horticulture Information Leaflet #528 covers all aspects of height control for greenhouse crops (see page 15 of the February 1991 issue for ordering HIL #528). This article focuses only on bedding plants, and only on chemical control of bedding plant elongation.

Available Chemicals. There are currently four chemicals labeled for height control of bedding plants: A-Rest, B-Nine, Bonzi, and Cycocel. A-Rest has been in the trade since 1970 and is labeled for use on 16 bedding plant species. B-Nine is labeled for 14 bedding plant species and has been in use since 1962. Bonzi is the newest growth retardant of the group, receiving its label in 1986, and Bonzi is labeled for 12 bedding plant species. Cycocel is the senior chemical, introduced in 1960, but Cycocel is

labeled for only one bedding plant, seedling geraniums. Perhaps next year we can add Sumagic to the list of available chemicals, as Valent U.S.A. Corporation (U.S. exclusive sales agent for Sumitomo Chemical Company, Limited), is in the process of applying for labelling of Sumagic.

Selecting the Best Chemical for Your Situation. Once you have decided that your situation requires chemical height control for holding back your bedding plants, the question of which chemical to use surfaces. That decision should be based at least in part on the answers to the following questions: ❶ Is the chemical registered for use on the target species? Table 1 lists registered chemicals and registered concentrations for bedding plants in flats or pots and Table 2 lists them for plugs. Many bedding plant species not listed in Tables 1 and 2 respond to the chemicals (Table 3), but it is illegal to treat them if they do not appear on the label. ❷ Does treatment with the product cause undesirable side effects? Phytotoxic responses such as leaf spots and burning, delays in flowering, and a reduction in flower size have been reported with certain combinations of growth retardants, plant species, and environmental conditions. For

Table 1. Chemical growth retardants labeled for use on bedding plants in flats or pots.

Bedding plant species	Labeled growth retardant	Suggested concentration and application method	Comments
Ageratum	A-Rest	33-66 ppm Spray	High rates of A-Rest may cause leaf crinkling.
	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
	Bonzi	63 ppm Spray	
Aster	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Balsam	A-Rest	33-132 ppm Spray	
Begonia	B-Nine	5000 ppm Spray	
Celosia	A-Rest	33-66 ppm Spray	
	B-Nine	2500 ppm Spray	Repeat applications every 7-10 days may be needed.
	Bonzi	16-50 ppm Spray	Bonzi will also cause increased branching of celosia plants.
Cleome	A-Rest	33-132 ppm Spray	
Coleus	A-Rest	33-66 ppm Spray	
	Bonzi	50-63 ppm Spray	
Cornflower	A-Rest	33-66 ppm Spray	
Cosmos	B-Nine	5000 ppm Spray	
Dahlia	A-Rest	0.25-0.50 mg a.i./ 6" pot Spray-Drench	Dose is 4 fl oz of 2.1-4.2 ppm solution per 6" pot (4 fl oz/110 cubic inches of soil). A standard 48-cell flat contains approximately 259 cubic inches, so apply 9.5 fl oz of spray-drench per 48-cell flat of dahlias. Spray-drench volume will vary with cell sizes (soil volume/flat) used.
	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Dianthus	A-Rest	33-66 ppm Spray	
	Bonzi	63 ppm Spray	
Dusty Miller	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Geraniums from cuttings	A-Rest	66-132 ppm Spray	
	Bonzi	6-16 ppm Spray	
Geraniums from seed	A-Rest	66-132 ppm Spray	Make the first application of growth retardant when 3-4 true leaves are present and the largest leaf is the size of a quarter (15/16") in diameter.
	Bonzi	6-16 ppm Spray	
	Cycocel	1500 ppm Spray	
Gerbera Daisy	A-Rest	33-66 ppm Spray	
Impatiens	Bonzi	63 ppm Spray	Multiple applications may be needed.
Marigold, African	A-Rest	33-66 ppm Spray	Repeat applications of A-Rest or B-Nine every 14-21 days may be needed.
	B-Nine	2500-5000 ppm Spray	
	Bonzi	63 ppm Spray	
New Guinea Impatiens	Bonzi	63 ppm Spray	
Pansy	Bonzi	16-33 ppm Spray	Pansies are very responsive to Bonzi, so start with lowest concentration.
Petunia	A-Rest	132 ppm Spray	Make the first application when plants are a half-dollar (1 7/32") in diameter.
	B-Nine	2500-5000 ppm Spray	
	Bonzi	63 ppm Spray	
Phlox	B-Nine	5000 ppm Spray	
Salvia	A-Rest	33-66 ppm Spray	A-Rest may speed flower bud set for salvia
	B-Nine	5000 ppm Spray	Multiple applications may be needed.
Snapdragon	Bonzi	63 ppm Spray	Repeat applications every 14-21 days may be needed.
Verbena	B-Nine	5000 ppm Spray	
Vinca	A-Rest	33-50 ppm Spray	
	B-Nine	2500 ppm Spray	
	Bonzi	8-16 ppm Spray	Bonzi can cause foliar injury on vinca, especially during warm weather.
Zinnia	A-Rest	33-66 ppm Spray	
	B-Nine	2500-5000 ppm Spray	

Table 2. Chemical growth retardants labeled for use on bedding plant plugs.

Bedding plant species	Labeled growth retardant	Suggested concentration and application method	Comments
Ageratum	A-Rest	16-33 ppm Spray	One application is usually sufficient for height control in the plug stage.
	B-Nine	2500-5000 ppm Spray	Repeat applications every 7-10 days may be needed. Too late an application may delay flowering.
	Bonzi	16 ppm Spray	
Aster	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Balsam	A-Rest	16-33 ppm Spray	
Begonia	B-Nine	5000 ppm Spray	
Celosia	A-Rest	16-33 ppm Spray	
	B-Nine	2500 ppm Spray	Repeat applications every 7-10 days may be needed.
	Bonzi	4-16 ppm Spray	
Cleome	A-Rest	16-33 ppm Spray	
Coleus	A-Rest	16-33 ppm Spray	
	Bonzi	4-16 ppm Spray	
Cornflower	A-Rest	16-33 ppm Spray	
Cosmos	B-Nine	5000 ppm Spray	
Dahlia	A-Rest	0.125-0.25 mg a.i./ 6" pot Spray-Drench	Dose is 4 fl oz of 1.05-2.1 ppm solution per 6" pot (4 fl oz/110 cubic inches of soil). A square 288 plug tray contains approximately 110 cubic inches of soil, so apply 4 fl oz (1/2 cup) of spray-drench per 288 square plug tray of dahlias. Make the first application at the first true leaf stage. Spray-drench volume will vary with plug trays (soil volume/tray) used.
	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Dianthus	A-Rest	16-33 ppm Spray	
	Bonzi	2-6 ppm Spray	
Dusty Miller	B-Nine	5000 ppm Spray	Repeat applications every 7-10 days may be needed.
Geranium	A-Rest	33-66 ppm Spray	Make the first application of growth retardant when 2-3 true leaves are present and the leaves are the size of a dime (11/16") in diameter. For Cycocel, use 750 ppm for the first application then use 1500 ppm 14 days later, if needed.
	Bonzi	2-6 ppm Spray	
	Cycocel	750-1500 ppm Spray	
Gerbera Daisy	A-Rest	16-33 ppm Spray	Gerberas may not need height control in plug trays.
Impatiens	Bonzi	6-30 ppm Spray	Make the first application at the first true leaf stage. Multiple applications may be needed. Bonzi will stimulate branching as well as control height with impatiens.
Marigold, African	A-Rest	33 ppm Spray	Repeat applications of A-Rest or B-Nine every 14-21 days may be needed. Make the first application at the first true leaf stage.
	B-Nine	2500-5000 ppm Spray	
	Bonzi	16 ppm Spray	
Pansy	Bonzi	1-3 ppm Spray	Make the first application when 3 true leaves are present on plants. Earlier applications may stunt plants.
Petunia	A-Rest	33 ppm Spray	Make the first application at the first true leaf stage.
	B-Nine	2500-5000 ppm Spray	
	Bonzi	6-50 ppm Spray	Use 6-8 ppm Bonzi at the first true leaf stage, then 16 ppm at the second true leaf stage, if needed. The higher rates may be needed for late season plugs.
Phlox	B-Nine	5000 ppm Spray	
Salvia	A-Rest	8-33 ppm Spray	Use the low rate early in production. Apply 33 ppm 2 weeks prior to shipping plugs to tone and increase green color.
	B-Nine	5000 ppm Spray	Weekly applications may be needed, especially with <i>Salvia farinacea</i> cultivars.
Snapdragon	Bonzi	8-30 ppm Spray	Make the first application when two sets of true leaves are present.
Verbena	B-Nine	5000 ppm Spray	
Vinca	A-Rest	16-33 ppm Spray	
	B-Nine	2500 ppm Spray	
	Bonzi	8-16 ppm Spray	Bonzi can cause foliar injury on vinca, especially during warm weather.

Table 3. Chemical growth retardants reported to be effective for bedding plant height control.

Bedding plant species	Growth retardant	Reported concentration and application method for:	
		Bedding plants	Plugs
Abelmoschus	B-Nine	5000 ppm Spray	5000 ppm Spray
	Bonzi		3- 6 ppm Spray
	Cycocel	1500 ppm Spray	
Ageratum	Bonzi	60-90 ppm Spray	
Alyssum, Sweet	B-Nine	5000 ppm Spray	5000 ppm Spray
	Bonzi	8-16 ppm Spray	3-8 ppm Spray
Aster	A-Rest	33-66 ppm Spray	
Basil, Ornamental	B-Nine	5000-7500 ppm Spray	5000 ppm Spray
Begonia	Bonzi	4 ppm Spray	1 ppm Spray
Browallia	A-Rest	33-66 ppm Spray	
	B-Nine	5000 ppm Spray	5000 ppm Spray
	Bonzi	16-30 ppm Spray	8-16 ppm Spray
Calendula	Bonzi	30-63 ppm Spray	
Carnation	A-Rest	33-66 ppm Spray	
	Bonzi	8-16 ppm Spray	1-4 ppm Spray
	Cycocel	1500 ppm Spray	750 ppm Spray
Cleome	Cycocel	1500 ppm Spray	
Coleus	Bonzi	60-90 ppm Spray	
Coreopsis	B-Nine	5000 ppm Spray	5000 ppm Spray
Cornflower	B-Nine	5000 ppm Spray	
Cosmos	Bonzi	16-30 ppm Spray	16 ppm Spray
Dahlberg Daisy	B-Nine	5000 ppm Spray	5000 ppm Spray
Dahlia	Bonzi	16-30 ppm Spray	16 ppm Spray
Dianthus	Bonzi	90-150 ppm Spray	
	Cycocel	1500 ppm Spray	750 ppm Spray
Dusty Miller	Bonzi	8-16 ppm Spray	2-4 ppm Spray
Flowering Cabbage and Flowering Kale	B-Nine	5000 ppm Spray	5000 ppm Spray
Gazania	B-Nine	5000 ppm Spray	5000 ppm Spray
Geranium	Bonzi	30-90 ppm Spray	
Gerbera Daisy	B-Nine	5000 ppm Spray	5000 ppm Spray
Hypoestes	Cycocel	1500 ppm Spray	
Impatiens	A-Rest	33-66 ppm Spray	
	B-Nine	7500 ppm Spray	5000 ppm Spray
	Bonzi	90-150 ppm Spray	
Lisianthus	B-Nine	5000 ppm Spray	5000 ppm Spray
Lobelia	A-Rest	33-66 ppm Spray	33 ppm Spray
	B-Nine	5000 ppm Spray	5000 ppm Spray
	Bonzi	4-8 ppm Spray	2-4 ppm Spray
Marigold, African	Bonzi	60-90 ppm Spray	
	Cycocel	1500 ppm Spray	
Melampodium	B-Nine	5000 ppm Spray	
Nicotiana	B-Nine	5000 ppm Spray	5000 ppm Spray
Petunia	Bonzi	90-150 ppm Spray	
Portulaca	B-Nine	5000 ppm Spray	5000 ppm Spray
Salvia	Bonzi	30-63 ppm Spray	8-16 ppm Spray
	Cycocel	1700 ppm Spray	750 ppm Spray
Snapdragon	A-Rest	33-66 ppm Spray	33 ppm Spray
	Bonzi	90-150 ppm Spray	
Verbena	A-Rest	33-66 ppm Spray	33 ppm Spray
	Bonzi	30 ppm Spray	16-30 ppm Spray
	Cycocel	1500 ppm Spray	

example, Bonzi sprays can cause spotting of vinca foliage, if plants are grown at high temperatures. ③ How expensive is it to use the chemical? Cost of the chemical should be calculated on a per flat/pot basis and a per application basis (Table 4). Please note that Table 4 lists the chemical cost only and does not address labor or equipment costs. ④ How often will the growth retardant need to be applied to maintain effective height control? Remember that chemical cost of a single application is not the total cost of height control encountered for the entire crop. Labor involved in mixing and applying the growth retardant should be evaluated along with how long the treatment will control elongation. For example, a grower is producing flats of celosia. The cultural practices employed (temperature, light, humidity, fertilization program, etc.) dictate that chemical height control is needed. The example grower's experience and records show that 2500 ppm B-Nine sprays are effective, if applied every 7 days; 33 ppm Bonzi sprays were also found to be effective, if applied every 3 weeks. Although the cost of a single 2500 ppm B-Nine spray is less than 33 ppm Bonzi, the

Table 4. Chemical costs for growth retardant sprays.

Chemical	Cost per container of chemical*	Concentration applied (ppm)	Amount of chemical needed for 10 gallons of spray**	Cost per 100 square feet of bench area sprayed***
A-Rest	\$50/quart	16	2.4 quarts	\$6.07
		33	5 quarts	\$12.50
		66	10 quarts	\$25.00
		132	20 quarts	\$50.00
B-Nine	\$296/5 lbs	2500	3.9 oz.	\$0.73
		5000	7.9 oz.	\$1.46
Bonzi	\$93/quart	2	0.64 fl. oz.	\$0.10
		8	2.56 fl. oz.	\$0.38
		16	5.12 fl. oz.	\$0.75
		33	10.56 fl. oz.	\$1.54
		50	16 fl. oz.	\$2.36
		63	20.16 fl. oz.	\$2.93
Cycocel	\$58/quart	750	8.1 fl. oz.	\$0.74
		1500	16.3 fl. oz.	\$1.48
		2000	21.7 fl. oz.	\$1.97

*These costs were taken from one source. Price will vary with suppliers and quantity discounts.

**Assuming an application rate of 2 quarts per 100 square feet, this amount of chemical will treat 2000 sq. ft. of bench area.

***Assuming an application rate of 2 quarts per 100 sq. ft. of bench area. The cost per 11" X 21" flat (assuming flat-to-flat spacing) can be calculated by dividing the figures in this column by 62.33. For example, a 5000 ppm B-Nine spray will cost ~2.4¢ in chemical per flat.

Bonzi program may be less expensive overall, since only one application is needed for every three B-Nine applications (during a 3 week period, a chemical cost of \$2.19/100 ft² for B-Nine and \$1.54 for Bonzi). Another point concerning how long a treatment will check growth: do not apply growth retardants too late in the production cycle or flowering and/or growth may be delayed. In the celosia example, if only one week of control is needed, perhaps the B-Nine spray would be better than the longer acting Bonzi treatment. The example given above may not hold true in every case and is offered as demonstration only.

Keep in mind that how long the treatment will control elongation will vary with your particular growing situation. Light intensity, time of year (photoperiod), temperature (day and night), humidity, fertilization program and a host of other factors are all involved in the effectiveness or efficacy of a chemical growth retardant.

Treatment Considerations. As the chemicals used become more effective and the cost increases, it becomes increasingly important to apply growth retardants in the most efficient manner possible. When setting up a chemical growth retardant program, 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. For example, a 1-3 ppm Bonzi spray on pansy plugs should not be made until three true leaves are present on the plants. Earlier applications may stop plant growth. Apply prior to rapid shoot elongation. These are chemical growth retardants not plant reducers--they cannot shrink plant growth already present. Make final applications 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 is too late an application of B-Nine or Bonzi on ageratum resulting in a delay in flowering. Remember that the timing of an 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 2 weeks after transplanting. 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. For example, it is recommended that the first growth retardant

treatment on seedling geraniums be made when 3–4 true leaves are present and the largest leaf is the size of a quarter (15/16").

Target: The target tissue or plant part to receive the chemical depends on the chemical used and the plant species being grown. With the exception of A-Rest drenches on dahlias where roots are the target tissue, bedding plant foliage and stems are the targeted tissue and chemicals are applied as a spray.

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 and unrepeatable.

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. The major application method employed for bedding plants is spraying the leaves and stems. Spray applications can be 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. This technique is **not recommended**. 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 ft². The 1/2 gallon per 100 ft² is sufficient to comfortably walk 25 feet while spraying a 4 foot-wide bench, thus the basis for the recommendation. The spray concentrations given in Tables 1-3 are based on delivering this volume as well. If more or less spray solution is applied, the degree of height control may be too little or too great. When an area is sprayed evenly, it assures that each flat or pot will receive the same amount of spray, regardless of how many containers are in the area. Unless growers measure out the spray applied to each flat or pot (or calibrate the output rate and time the spray for each unit while maintaining a constant tank pressure), there is no other way to evenly apply the spray over plants.

When addressing height control for bedding plants, remember to evaluate all available possibilities. If chemical control is the most feasible choice, make applications correctly and accurately. Select the chemical that is appropriate for your situation, based on cost and plant quality factors. Uniformity and consistency in application 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.

1991 NORTH CAROLINA BEDDING PLANT FIELD DAY

Wednesday, 31 July 1991

University Research Unit 4 (Site of the NCSU Arboretum)
4301 Beryl Road, Raleigh, NC
9:45–11:45 Self-Guided Tour of Trial Area, featuring over 500 annuals

J.S. McKimmon Extension Education Center
Gorman Street, Raleigh, NC
12:00–1:15 Buffet Luncheon
1:15–4:00 Oral Sessions:

Session For Growers:

- Poinsettia Disease Update
- Cultural Update on Poinsettias
- Insect Control on Poinsettias

Session For Landscapers & Retailers:

- Insect Control on Landscape Bedding Plants
- Bedding Plant Trial Report and Update on New Varieties
- Disease Control on Landscape Bedding Plants