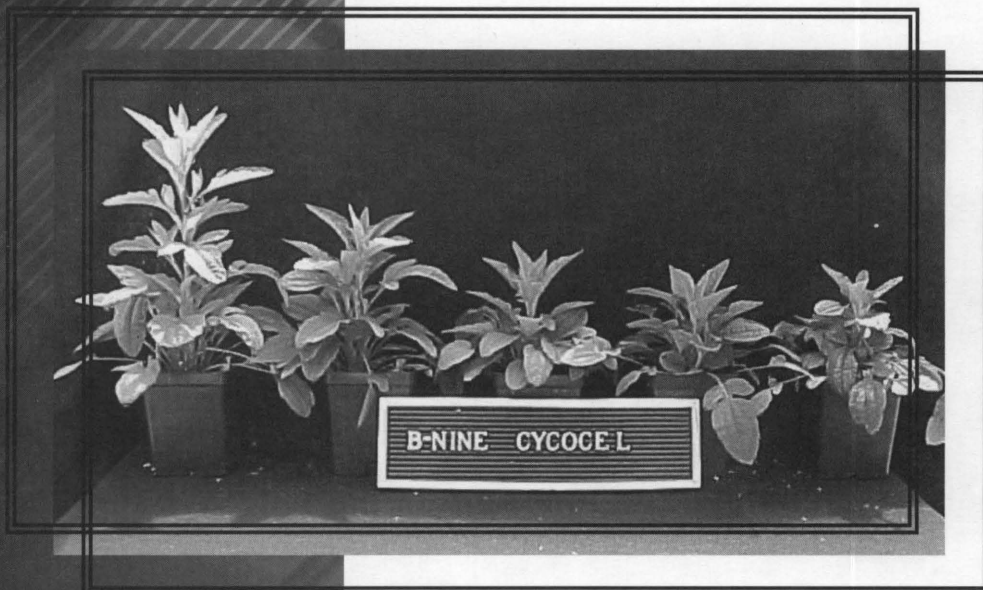


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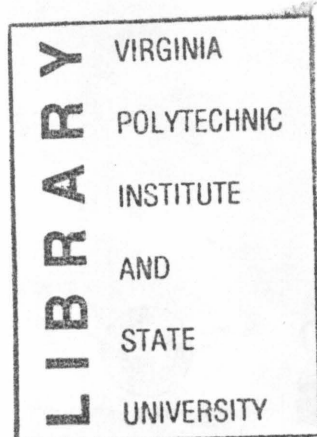


VIRGINIA STATE UNIVERSITY

Using Plant Growth Regulators on Containerized Herbaceous Perennials

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Production of Herbaceous Perennials

There is a tremendous diversity of herbaceous perennial plant species being grown for both the retail and landscaping sectors of the industry. Because of the diversity in species grown, there is much more unknown about perennials production than is known. Growth regulation is of particular concern. In production settings, as well as in retail locations, herbaceous perennials grown in pots tend to stretch and become leggy or simply overgrow their pots before their scheduled market date. These plants are less marketable, and harder to maintain. Many growers resort to pruning, which is not only costly in terms of labor, but also delays plant production two to four weeks.

Availability of chemical plant growth regulators (PGRs) for perennials is not a problem. Due to recent label expansions, all of the primary floriculture growth retardants are labeled for use on perennials. However, lack of knowledge about rates and the diversity of plant responses to these PGRs are problems. Many of the herbaceous perennials in the market have never been evaluated for response to any of these chemicals.

A summary of the results of research trials using PGRs on over 100 perennial species/cultivars is presented in Table 1. This summary includes rates found effective in reducing plant height in published articles, as well as many of our own research results. Foliar spray applications are tested more often than drenches, presumably due to the higher labor costs involved in applying drenches in large scale production areas.

Application Guidelines

Pay particular attention to application instructions on PGR labels. For soil active PGRs like A-Rest, Bonzi and Sumagic, the dose applied to the plant is a function of both the solution rate (ppm active ingredient) and the volume applied to plant and its substrate. For foliar sprays, all plants should be treated according to a specified volume of PGR applied to a specified area of bench, not to the individual plants. Generally, the labels recommend 2 qt. per 100 sq.ft. of bench which is sufficient to cover the plant and permit a small amount of runoff onto the medium. While 50 ppm Bonzi applied at the label recommended volume resulted in acceptable height control of hollyhock (*Alcea rosea*), application of the same rate at twice the

recommended volume resulted in excessive growth reductions (Figure 1).

Treatment of large or dense plants may require higher volumes to treat the interior portions of the plant. However, remember that deviations from the recommended volumes applied will result in a different dosage of PGR applied. Always consider the rates presented in Table 1, or from any other resource, to be a guideline to assist you in developing your own rates based on your growing conditions and application methods.

Plant growth regulators should be applied to new growth (1.5 to 2" long) before it enters the rapid elongation phase. Generally, PGRs should be applied before flower initiation to minimize flowering delays. Remember that reductions in plant height are not always the growth control desired during production. For gaura (*Gaura lindheimeri*), where excessive height was not a production issue, B-Nine or a B-Nine/Cycocel Tank Mix was very effective in reducing plant width (Figure 2). In cases like this, the results may not be indicated in Table 1.

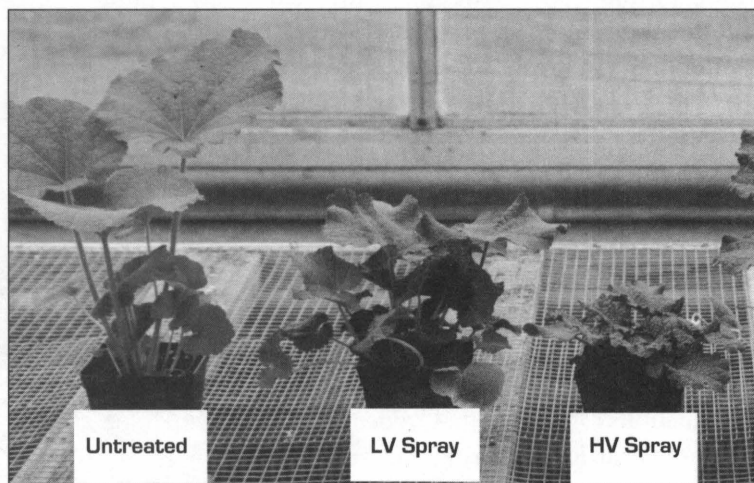


Figure 1. Application volume affects plant response to soil-active PGRs like Bonzi: hollyhock (*Alcea rosea*) treated with 50 ppm Bonzi: untreated control (left), at label recommended volume of 2 qt. per 100 sq. ft. (center) or at twice the label recommended volume [4 qt. per 100 sq. ft.].

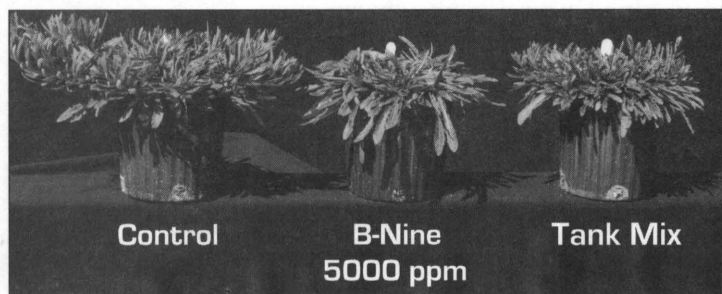


Figure 2. PGRs may affect plant width more than height: gaura (*Gaura lindheimeri* 'Siskiyou Pink') untreated (left), 5000 ppm B-Nine applied twice (center), and a Tank Mix of 5000 ppm B-Nine plus 1500 ppm Cycocel applied once (right). Photograph at six weeks after treatment.

Specific Plant Growth Regulators

B-Nine (daminozide, Uniroyal Chemical Company) is the most commonly used PGR in the floriculture industry. In general, it is not phytotoxic, and has a short-term effect that seldom results in overstunting of treated plants. Due to the low activity of B-Nine and its lack of soil activity, it is easier to apply consistently than the newer, more potent PGR chemistries. The low activity also means that B-Nine must be applied more frequently to maintain control over vigorous crops. Nearly one-half of the perennials tested have shown some response to multiple applications of B-Nine (Table 1). Generally, foliar sprays of 5000 ppm are applied every 10 to 14 days as necessary. B-Nine 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.

Cycocel (chlormequat chloride, Olympic Horticultural Products) is another PGR with a long history in floriculture. Cycocel is generally applied as a foliar spray at 1500 to 3000 ppm. Although rates above 1500 ppm often cause chlorosis on treated leaves of other floricultural crops, we have seen few examples of phytotoxicity on perennials. However, Cycocel alone has not been tested on a wide variety of perennials. It was very effective on *Campanula carpatica* and purple coneflower (*Echinacea purpurea*) where multiple applications of 1500 ppm resulted in excessive reductions in growth (Table 1). Rose mallow (*Hibiscus moscheutos*) also is sensitive to Cycocel, responding well to multiple applications of 1000 ppm. Cycocel also promotes earlier flowering and greater flower numbers on *Hibiscus*. First application should be made when the laterals are 0.5 to 1 inch long.

A **B-Nine/Cycocel Tank Mix** has more PGR activity than either B-Nine or Cycocel alone and has been tested on a wide variety of perennials. Three-lobed coneflower (*Rudbeckia triloba*) was very responsive to B-Nine applied twice at 5000 ppm, but not responsive to Cycocel at rates up to 4000 ppm (Figure 3a). A tank mix of 5000 ppm B-Nine with increasing rates of Cycocel resulted in similar height control with a single application at four

weeks prior to the photograph (Figure 3b). The "high activity" rate generally used for the tank mix is 5000 ppm B-Nine plus 1500 ppm Cycocel. Although the rate of B-Nine is usually adjusted to increase or decrease activity, changing the Cycocel rate also affects activity. Shoot height of 31 of the perennials listed in Table 1 was effectively controlled by this tank mix including blanket flower (*Gaillardia grandiflora*) and Russian sage (*Perovskia atriplicifolia*) (Figure 4). As described with speedwell, single applications of the tank mix may be more effective than multiple applications of B-Nine alone. In other crops in Table 1 where the tank mix is listed as non-responsive (NR) with one application, the effects may have been too short term for the research evaluation. Multiple applications of the tank mix may provide control on these species.

A-Rest (ancymidol, SePRO Corporation) is a more active compound than B-Nine or Cycocel. It is labeled for use on containerized plants in greenhouses and nurseries. A-Rest is active as a spray or a drench so application volume affects plant response. In addition, A-Rest is one of the few PGRs labeled for distribution through the irrigation system via flood, sprinkler or drip systems. Although it has not been evaluated for effectiveness on a large number of perennial species, A-Rest is specifically labeled for foliar sprays on bleeding heart (*Dicentra*) and columbine (*Aquilegia*) at 65 to 132 ppm, gayfeather (*Liatris*) (25 to 132 ppm) and hybrid bee delphinium (*Delphinium*) (35 to 132 ppm).

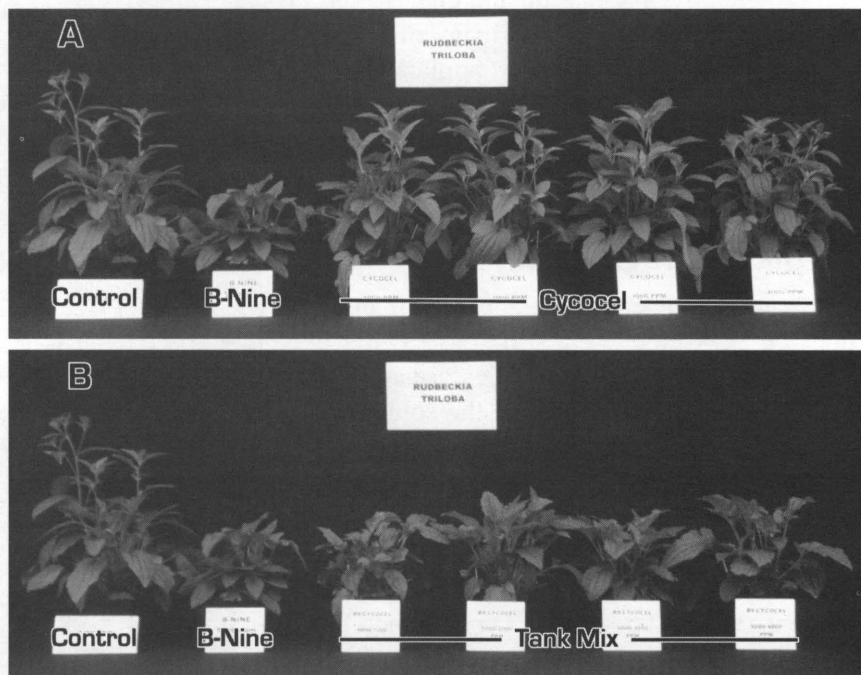


Figure 3. Three-lobed coneflower (*Rudbeckia triloba*) was very responsive to B-Nine applied twice at 5000 ppm, a) but not responsive to Cycocel at rates of 1000, 2000, 3000, or 4000 ppm (left to right). b) A tank mix of 5000 ppm B-Nine with these increasing rates of Cycocel showed significant height control with a single application four weeks prior to the photograph.

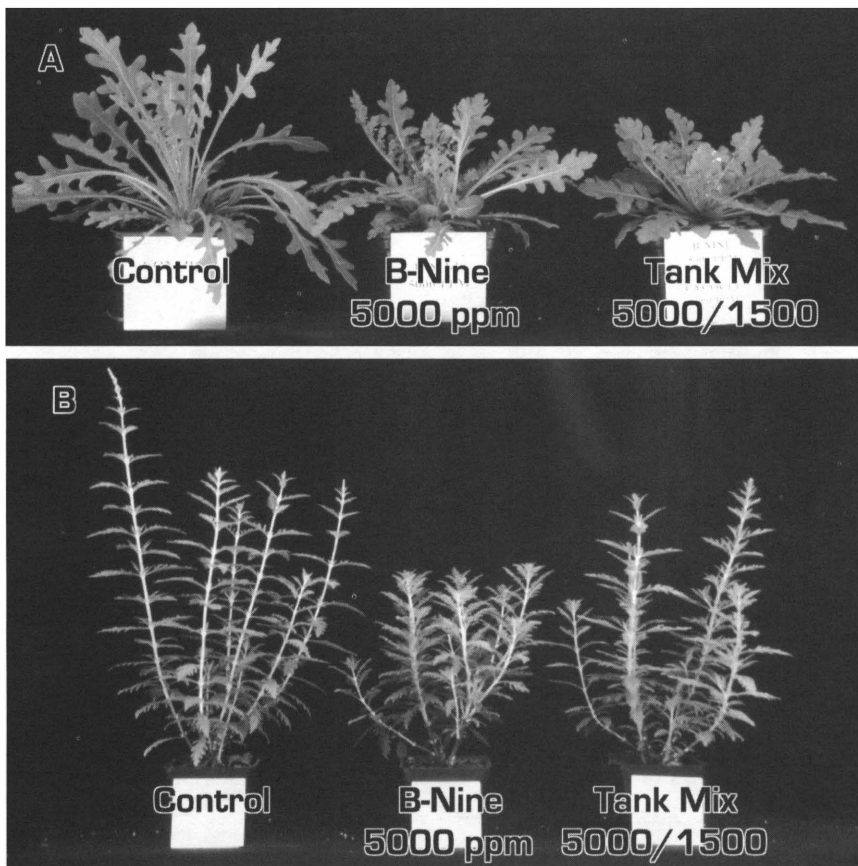


Figure 4. A single application of a Tank Mix of 5000 ppm B-Nine plus 1500 ppm Cycocel may be more effective than multiple applications of B-Nine alone: Untreated control (left), 5000 ppm B-Nine applied twice (center), or Tank Mix applied once to a) blanket flower (*Gaillardia grandiflora* 'Burgundy') and b) Russian sage (*Perovskia atriplicifolia*). Photograph at five weeks after treatment.

A-Rest also can be applied as a drench at 2 to 4 ppm for these crops. For best results, treatments should be applied to well-rooted plants in active growth, prior to the initiation of flowering. In research reports, tickseed (*Coreopsis*) was not responsive to A-Rest, but *Campanula*, hardy ageratum (*Eupatorium*), purple coneflower (*Echinacea*), lavender (*Lavandula*), cardinal flower (*Lobelia*) and speedwell (*Veronica*) were very responsive (Table 1). The higher rates necessary for foliar applications to some crops may not be economically feasible. The use of A-Rest as a drench or as a treatment of plants in the plug stage is more economical than foliar application on finished plants.

Bonzi (paclobutrazol, Uniroyal Chemical Company) and **Sumagic** (uniconazole, Valent USA) are members of the triazole class of PGRs and are much more active than the previous compounds. Sumagic is more potent than Bonzi. For perennials, Bonzi is generally applied at rates of 30 to 100 ppm and Sumagic at 15 to 45 ppm. 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, uniform application of a consistent volume per unit area is critical to uniform and consistent crop responses to the triazoles. Both compounds are labeled for application to the media surface prior to planting plugs. In this case the PGR is applied as a spray (at rates one-third to one-half the recommended foliar spray rate) to the surface of the medium in filled pots. The PGR moves into the medium with subsequent irrigations and effectively behaves as a drench which is the reason for the lower recommended rate. Effectiveness also is reduced by bark in the medium as it is with drenches.

Neither PGR has exhibited any specific phytotoxicity symptoms on perennials, but care must be taken with application of excessive rates on sensitive plants. In some cases, excessive stunting can be very persistent, e.g., goldenrod (*Solidago sphacelata*) treated with higher rates of Bonzi (240 ppm) or Sumagic (60 ppm) did not recover normal size at five months after planting into the landscape.

Growth of velvet sage (*Salvia leucantha*) was excessively reduced by 45 or 60 ppm Sumagic in the greenhouse (Figure 5a). Furthermore, 60 ppm Sumagic caused a significant delay in landscape growth (Figure 5b). 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. The persistence of these compounds in plant stems and petioles can have significant effects on the flower display as well. As with many of the growth retardants, the triazoles inhibit gibberellin synthesis. Generally, the most rapidly elongating tissues have the highest production of gibberellins and, therefore, are most affected by reductions in gibberellin production. For example, elongation of the flower inflorescences of gaura (*Gaura lindheimeri*) was much more sensitive to growth inhibition than was the elongation of the stem tissues (Figure 6). Usually this is acceptable because it keeps the flower height in better proportion to the plant

height. However, differences in response vary, and in some yarrow (*Achillea*) cultivars, flower height has been excessively reduced at moderate application rates.

Bonzi has a broad label for ornamentals that includes use on greenhouse or outdoor grown containerized crops. Bonzi also is labeled for application through the irrigation system or by subirrigation, including ebb/flow or flooded floor systems. Bonzi has been tested on a wide variety of perennials with species ranging from extremely sensitive to low rates to non-responsive to very high rates. To establish rates for plants not listed in Table 1 or on the product label, treat a small number of plants with 30 to 100 ppm. 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.

Sumagic also has a broad label for ornamentals, but its use is limited to containerized plants grown in greenhouses, overwintering structures, shade houses, or lath houses. It is not labeled for outdoor nursery use. At this time, Sumagic is not labeled for application through any irrigation system. Sumagic has been very effective on a large number of perennials. Test rates in the 15 to 45 ppm range. Since it is very potent, pay special attention to uniform application and proper volumes. Use caution in the higher rates or on more sensitive species since Sumagic can be very persistent in the landscape (Figure 5b).

Florel Brand Pistill (Florel) (ethephon, Monterey Chemical) 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 upon the species and the stage of growth at time of application. It has a new broad use label (EPA Reg. No. 54705-8) for increasing lateral branching of floricultural crops. Florel also inhibits internode elongation of many plants; however, research with perennials has been limited (Table 1). Florel has controlled runner elongation of clump verbena (*Verbena* 'Homestead Purple'), and increased inflorescence numbers of sage (*Salvia* 'May Night') (Figure 7) and yarrow (*Achillea*). Florel should be applied to actively growing plants prior to flower development. If flowers are present,

they are likely to abort. Florel may delay flowering about one to two weeks, particularly if applied close to time of flower initiation. Florel should not be applied to plants that are heat or drought stressed. The pH of the 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

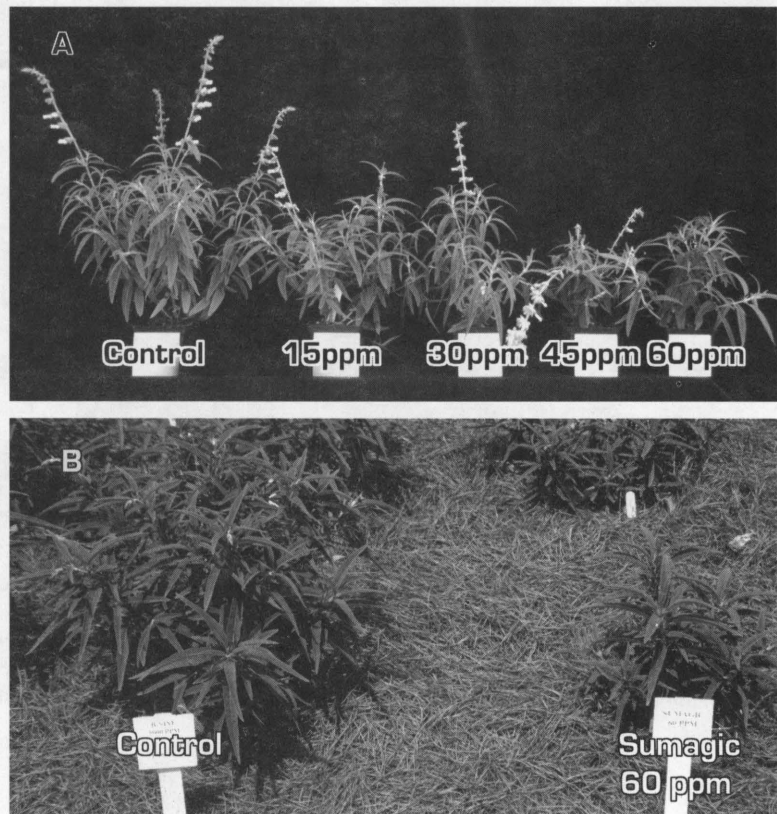


Figure 5. Greenhouse applications can cause significant delays in the resumption of growth in the landscape: velvet sage (*Salvia leucantha*) a) in the greenhouse at five weeks after treatment with one application of Sumagic at 0, 15, 30, 45, or 60 ppm (left to right); b) at eight weeks after planting into the landscape, 12 weeks after treatment with 60 ppm Sumagic (right) or untreated (left).

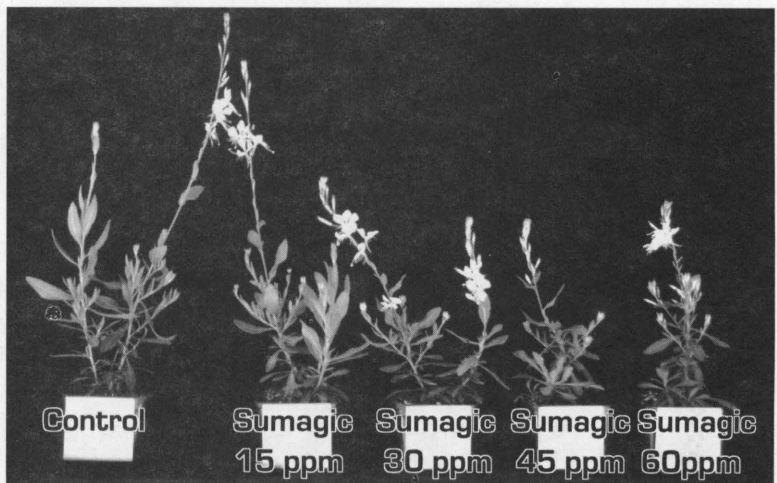


Figure 6. Elongation of flower inflorescence may be more affected by PGRs than elongation of stem tissue, as seen with gaura (*Gaura lindheimeri* 'Siskiyou Pink') treated with increasing rates of Sumagic (0, 15, 30, 45 or 60 ppm, left to right). Photograph at five weeks after treatment.

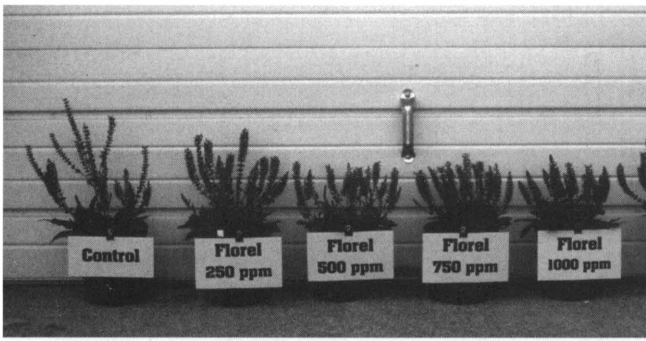


Figure 7. Florel at 0, 250, 500 750, or 1000 ppm (left to right) increased the number of flowers while reducing overall plant height of hybrid sage (*Salvia x sylvestris* 'May Night'). Photograph at six weeks after treatment.

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.

Atrimmec (dikegulac sodium, PBI Gordon) is a compound that interferes with terminal growth by inhibiting deoxyribonucleic acid (DNA) synthesis which is required for new growth. By primarily inhibiting terminals, apical dominance is reduced which enhances the production of lateral branches. This mode of action tends to cause a delay in the resumption of plant growth that may add 2 to 4 weeks to production time. Atrimmec is labeled for use on containerized and landscape woody ornamentals, but also is labeled for use on

some hanging basket plants and groundcovers. Of particular interest to perennials growers is its label for lantana (*Lantana camara*) (750 to 1500 ppm) and butterfly bush (*Buddleia*) (530 to 1500 ppm). Atrimmec should be applied to actively growing plants with at least two nodes to provide sufficient lateral development. In addition to creating a more full plant, enhancing the number of laterals in a pot generally reduces the overall height of the plant due to the greater distribution of resources. Responses are very species specific so test several rates under your growing conditions. Atrimmec usually causes leaf chlorosis which can be very persistent at higher rates (above 1500 ppm). Other phytotoxic responses, including malformed flowers, have been noted at higher rates on perennials such as gayfeather (*Liatris spicata*).

Summary

Growth regulation by PGRs is impacted by all other phases of plant culture. Remember that you have to fit PGRs into your own production program. Plan to use PGRs. Don't use them as an afterthought when the plants are out of control. You can not "shrink" an overgrown plant. Always consider any rate recommendation as a starting point for your own trials and keep records of your successes and failures with PGRs. Whenever you treat your crop, hold back a few untreated plants so that you can judge the effectiveness of your treatment. As covered in more detail in VCE Publication 430-102, *Selecting and Using Plant Growth Regulators on Floricultural Crops*, methods of application have significant effects on results. Develop your own program. Then test and refine it.

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.

Table 1. Summary of research results on the use of plant growth regulators (PGRs) on containerized, herbaceous perennials. Rates listed were tested as spray applications at label-recommended volumes unless otherwise stated. The rates listed should be used as starting points for your own PGR trials. Multiple applications are generally applied 10-14 days apart. Note: "NR" means the plants were not responsive to the rates tested.

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Achillea</i> x 'Coronation Gold'	Yarrow	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	30 to 40 x 1	
		Cycocel	NR @ 4000 x 1	
		Florel	500 x 1	Delayed flowering. Apply before visible bud.
		Sumagic	Less than 15 x 1	Persistent reductions in plant growth continue in the landscape.
<i>Achillea</i> x 'Moonshine'	Yarrow	B-Nine	NR @ 5000 x 2	
		Bonzi	Much less than 240 x 1	This rate caused excessive height reduction. Test rates much lower than 240 ppm.
		Sumagic	NR @ 60 x 1	
<i>Achillea</i> x 'Paprika'	Yarrow	B-Nine	multiple @ 5000	Apply at 10-14 day intervals. May delay flowering.
		B-Nine/Cycocel	5000/1500 x 1	
		Sumagic	15 x 1	Plant width also reduced.
<i>Achillea</i> x 'Summer Pastels'	Yarrow	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	120 x 1 greater than 30 x 4	
		Cycocel	NR @ 4000 x 1	
		Sumagic	NR @ 60 x 1	
<i>Achillea millefolium</i> 'Weser River Sandstone'	Yarrow	Florel	1000 x 3	Increased number of flowers; height control moderate.
<i>Agapanthus</i>	African Lily	Bonzi	Greater than 30 x 1 (drench)	
<i>Agastache</i> x 'Blue Fortune' ^z	Anise Hyssop	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Sumagic	Less than 15 x 1	Very sensitive to Sumagic. Apply at rates much lower than 15 ppm.
<i>Alcea rosea</i> 'Powder Puff Mix' 'Chater's Double Mix'	Hollyhock	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	30 to 50 x 1	
		Bonzi	1.5 x 1 (drench)	
		Florel	500 x 2	
		Sumagic	Much less than 15 x 1	Very sensitive to Sumagic. Test rates much lower than 15 ppm.
<i>Aquilegia</i> x <i>hybrida</i> 'McKana Giants'	Hybrid Columbine	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		Bonzi	NR @ 240 x 1	
		Sumagic	NR @ 120 x 1	
<i>Asclepias tuberosa</i> 'Royal Red'	Butterfly Weed	B-Nine	5000 x 3-4	Apply at 10-14 day intervals.
		Bonzi	30 x 4	
<i>Aster</i> x <i>frikartii</i> 'Monch' 'Monarch' 'Alpine Mix'	Frikart's Aster	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	NR @ 240 x 1; NR @ 30 x 4	
		Bonzi	12-16 x 1 (drench)	
		Sumagic	NR @ 60 x 1	
<i>Astilbe</i> x <i>arendsii</i> 'Bressingham Beauty'	Hybrid Astilbe	B-Nine	5000 x 4	Apply weekly beginning just after inflorescence begins to elongate.
		Bonzi	Greater than 30 x 4	
		Bonzi	30 x 1 (drench)	
<i>Baptisia</i>	False Indigo	Bonzi	30 x 1 (drench)	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Barleria cristata</i>	Phillippine Violet	B-Nine	5000 x 3	Apply at 10-14 day intervals.
		Bonzi	Greater than 45 x 1	
<i>Boltonia asteroides</i>	Bolton's Aster	Bonzi	>30 x 1 (drench)	
<i>Buddleia davidii</i> 'Pink Delight'	Butterfly Bush	Bonzi	Greater than 30 x 1 (drench)	
		B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Sumagic	NR @ 60 x 1	
<i>Buddleia davidii</i> 'Royal Red'	Butterfly Bush	A-Rest	Much less than 100 x 4	Excessive height reduction. Reduce rate or frequency.
		B-Nine	multiple @ 5000	Moderate control. Apply at 10-14 day intervals.
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	Greater than 40 x 1	
		Bonzi	5 x 1 (drench)	
		Sumagic	NR @ 60 x 1	
<i>Campanula carpatica</i> 'Blue Chips'	Carpathian Harebell	B-Nine	5000 x 2 to 4	Apply at 10-14 day intervals.
		Bonzi	Much less than 30 x 4	Excessive height reduction. Reduce rate or frequency.
		Cycocel	Much less than 1500 x 4	Excessive height reduction. Reduce rate or frequency.
		Sumagic	Much less than 15 x 4	Excessive height reduction. Reduce rate or frequency.
<i>Campanula persicifolia</i> 'Blue'	Peachleaf Bellflower	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
<i>Canna x generalis</i> 'Florence Vaughan'	Hybrid Canna	B-Nine	NR @ 7500 x 1	
		Bonzi	66 x 1	
		Florel	NR @ 1000 x 1	
<i>Canna x orchoides</i>	Hybrid Canna	B-Nine	NR @ 7500 x 1	Delayed flowering.
		Bonzi	66 to 99 x 1	
		Florel	NR @ 1000 x 1	
<i>Centaurea montana</i> 'Violet'	Mountain Bluet	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
<i>Chelone glabra</i>	White Turtle-head	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
		Bonzi	30 x 1 (drench)	
<i>Chrysanthemum coccineum</i> 'James Kelway'	Painted Daisy	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
		Bonzi	Much less than 40 x 1	Very sensitive to Bonzi. Test rates much lower than 40 ppm.
<i>Chrysanthemum parthenium</i>	Feverfew	Cycocel	750 x 1	
		Sumagic	Much lower than 15 x 1	Very sensitive to Sumagic. Test rates much lower than 15 ppm
<i>Coreopsis grandiflora</i> 'Sunray' 'Baby Sun'	Tickseed	A-Rest	NR @ 100 x 3	
		B-Nine	5000 x 3	May delay flowering. Apply at 10-14 day intervals.
		B-Nine/Bonzi	2500/20 to 40 x 1	
		B-Nine/Cycocel	2500/1500 x 1	
		Bonzi	80 to 100 x 1	
		Bonzi	5 to 10 x 1 (drench)	
		Sumagic	40 x 1 or 15 x 2	May delay flowering

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Coreopsis rosea</i>	Pink coreopsis	B-Nine	7500 x 1	
		Bonzi	NR @ 100 x 1	
		Bonzi	Greater than 4 x 1 (drench)	
		Sumagic	40 x 1	
<i>Coreopsis verticillata</i> 'Moonbeam'	Thread Leaf Coreopsis	A-Rest	NR @ 100 x 4	
		B-Nine	5000 x 2	Some flower delay. Apply at 10-14 day intervals.
		Bonzi	NR @ 160 x 1	
		Cycocel	NR @ 1500 x 4	
		Florel	NR @ 1000 x 3	
		Sumagic	15 x 4	
<i>Coreopsis verticillata</i> 'Zagreb'	Thread Leaf Coreopsis	B-Nine	5000 x 2	
		B-Nine/Cycocel	5000/1500 x 1	
		Florel	NR @ 500 x 2	
		Sumagic	20 x 1	
<i>Cortaderia selloana</i>	Pampas Grass	A-Rest	30 x 1 (drench)	
		Bonzi	15 x 1 (drench)	
		Sumagic	Much lower than 1 x 1	Very sensitive to Sumagic. Test rates below 1 ppm.
<i>Crocsmia</i>	Montbretia	B-Nine	NR @ 5000 x 4	
<i>Delphinium x elatum</i> 'Magic Fountains'	Hybrid Bee Delphinium	A-Rest	NR @ 100 x 3	
		B-Nine	NR @ 5000 x 3	
		Bonzi	Less than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
		Cycocel	NR @ 1500 x 3	
		Sumagic	Less than 15 x 3	
<i>Dendranthema zawadskii</i> 'Clara Curtis'	Garden Mum	B-Nine	Multiple at 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	Multiple applications required.
		Bonzi	Less than 40 x 1	Sensitive to Bonzi. Test rates less than 40 ppm.
		Sumagic	Less than 15 x 1	Sensitive to Sumagic. Test rates less than 15 ppm.
<i>Dicentra spectabilis</i>	Common Bleeding Heart	A-Rest	50 x 2	Phytotoxic, leaf tip chlorosis.
		B-Nine	3000 x 2	Slight delay in flowering
		Cycocel	NR @ 2000 x 2	
<i>Digitalis purpurea</i> 'Foxy'	Common Foxglove	B-Nine	NR @ 5000 x 4	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	80 to 160 x 1	
		Bonzi	2 to 4 x 1 (drench)	
		Sumagic	30 to 45 x 1	
<i>Duranta repens</i>	Golden Dewdrop	Bonzi	Greater than 100 x 1	
<i>Echinacea purpurea</i> 'Bravado'	Purple Coneflower	A-Rest	100 x 5	
		B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
		Cycocel	1500 x 5	Discolored leaves.
		Florel	500 x 3	Flower size reduced.
Sumagic	Much less than 40 x 1	Very sensitive to Sumagic. Test rates below 30 ppm		

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Echinacea purpurea</i> 'Magnus'	Purple Coneflower	B-Nine	5000 x 2	May require multiple applications at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Florel	500 x 2	
		Sumagic	NR @ 20 x 1	
<i>Eupatorium coelestinum</i>	Hardy Ageratum	B-Nine	NR @ 5000 x 2	
		Bonzi	NR @ 240 x 1	
		Bonzi	8 to 10 x 1 (drench)	
		Sumagic	60 x 1	
<i>Gaillardia x grandiflora</i> 'Burgundy'	Blanket Flower	B-Nine	5000 x 3	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Greater than 30 x 4	
		Sumagic	60 x 1	Moderate control. May require multiple applications.
<i>Gaillardia x grandiflora</i> 'Goblin'	Blanket Flower	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	5000/1500 x 1	Moderate control. Multiple applications may be required.
		Bonzi	NR @ 160 x 1	
		Florel	NR @ 500 x 2	
		Sumagic	NR @ 60 x 1	
<i>Gaura lindheimeri</i> 'Corrie's Gold'	Gaura	B-Nine	5000 x 2	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	80 x 1	
		Florel	500-1000 x 1	May delay flowering.
		Sumagic	30 x 1	May require multiple applications.
<i>Gaura lindheimeri</i> 'Siskiyou Pink'	Gaura	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Bonzi	2500/8 x 1	
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Greater than 30 x 4	
		Bonzi	Greater than 15 x 1 (drench)	
		Sumagic	NR @ 60 x 1	Plant width reduced.
<i>Gaura lindheimeri</i> 'Whirling Butterflies'	Gaura	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	Moderate control; multiple applications may be required.
		Sumagic	15 x 1	Test rates below 15 ppm.
<i>Gypsophila paniculata</i> 'Double Snowflake'	Baby's Breath	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
<i>Helenium autumnale</i>	Sneezeweed	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
<i>Heliopsis helianthoides</i> 'Summer Sun'	False Sunflower, Sunflower Heliopsis	B-Nine	Less than 5000 x 2	Sensitive to B-Nine. Test lower rate. Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	NR @ 160 x 1	
		Bonzi	30 x 1 (drench)	
		Florel	500 x 2	Moderate control.
<i>Heliotropium arborescens</i> 'Fragrant Blue'	Heliotrope	B-Nine	5000 x 3	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Sumagic	60 x 1	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Hemerocallis x</i> 'Halls Pink'	Daylily	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
<i>Heuchera sanguinea</i> 'Bressingham Hybrids'	Coral Bells	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
<i>Hibiscus moscheutos</i> 'Disco Belle Mixed'	Rose Mallow	Cycocel	1000 x 4	Multiple applications necessary.
		Sumagic	15 x 4	Multiple applications necessary.
<i>Hypericum calycinum</i>	Aaron's Beard, St. John's Wort	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	NR @ 160 x 1	
		Sumagic	30 x 1	
<i>Iris x germanica</i>	Bearded Iris	Bonzi	Greater than 160 x 1	
		Bonzi	Greater than 4 x 1 (drench)	
<i>Kniphofia uvaria</i> 'Bressingham Comet'	Red Hot Poker, Torchlily	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	NR @ 160 x 1	
		Cycocel	NR @ 4000x 1	
		Sumagic	45 x 1	
<i>Lantana camara</i> 'Confetti'	Lantana	B-Nine	5000 x 3	Moderate control. Apply at 10-14 day intervals.
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Sumagic	30 x 1	Moderate control.
<i>Lavandula angustifolia</i> 'Munstead Dwarf'	Common Lavender	A-Rest	Less than 100 x 3	Reduce rate or frequency.
		B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
		Cycocel	NR @ 1500 x 3	
		Sumagic	5 to 10 x 3	
<i>Leucanthemum x superbum</i> 'Alaska'	Shasta Daisy	B-Nine	NR @ 5000 x2	
		Bonzi	Less than 40 x 1	Sensitive to Bonzi. Test rates below 40 ppm.
		Cycocel	NR @ 4000 x 1	
		Sumagic	Less than 15 x 1	Sensitive to Sumagic. Test rates below 15 ppm.
<i>Leucanthemum x superbum</i> 'Becky'	Shasta Daisy	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	NR @ 100 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	NR @ 60 x 1	
<i>Leucanthemum x superbum</i> 'Snow Lady'	Shasta Daisy	Bonzi	Greater than 40 x 1	
<i>Leucanthemum x superbum</i> 'Thomas Killen'	Shasta Daisy	Florel	500 x 3	Flower size and plant quality reduced.
<i>Liatris spicata</i> 'Floristan Violet'	Spike Gayfeather	Bonzi	NR @ 160 x 1	
		Sumagic	NR @ 60 x 1	
<i>Liatris spicata</i> 'Kobold'	Spike Gayfeather	Florel	1000 x 3	Response small and inconsistent: flowering delayed
<i>Linum perenne</i> 'Sapphire'	Perennial Flax	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	>30 x 4	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Lobelia cardinalis</i>	Cardinal Flower	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/4000 x 1	
		Bonzi	NR @ 60 x 1	
		Sumagic	30 x 1	
<i>Lobelia x speciosa</i> 'Compliment Scarlet' 'Queen Victoria'	Hybrid Lobelia	A-Rest	Less than 100 x 3	Reduce rate or frequency.
		B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 1	May require multiple applications.
		Cycocel	1500 x 3	
		Sumagic	Much less than 15 x 3	Very sensitive to Sumagic. Test rates much lower than 15 ppm.
<i>Lythrum virgatum</i> 'Morden Pink'	Purple Loosestrife	B-Nine	5000 x 2	
		Florel	NR @ 500 x 2	
		Sumagic	15 x 2	
<i>Malva alcea</i>	Hollyhock Mallow	B-Nine	NR @ 5000 x 2	
		Bonzi	Much lower than 40 ppm x 1	Very sensitive to Bonzi. Test rates around 10 to 20 ppm.
		Cycocel	750-1500 x 1	
		Sumagic	Much lower than 15 ppm x 1	Very sensitive to Sumagic. Test rates around 2 to 5 ppm.
<i>Monarda didyma</i> 'Blue Stocking'	Bee-Balm	B-Nine	NR @ 5000 x 2	
		Bonzi	NR @ 160 x 1	
		Cycocel	NR @ 4000 x 1	
		Florel	500 x 3	Phytotoxic at 1000 ppm; use with caution; reduced number of flowers.
		Sumagic	15-30 x 1	
<i>Monarda didyma</i> 'Marshall's Delight'	Bee-Balm	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Sumagic	30 x 1	
<i>Monarda citriodora</i>	Bee-Balm	Bonzi	60-100 x 1	
		Bonzi	Greater than 4 x 1 (drench)	
<i>Nepeta x faassenii</i> 'Six Hills Giant'	Faassen Nepeta, Catmint	B-Nine	5000 x 2	
		Bonzi	30 x 2	May require multiple applications.
		Cycocel	NR @ 1500 x 2	
		Florel	500 x 2	May require multiple applications.
		Sumagic	15 x 2	
<i>Pachystachys lutea</i>	Golden Shrimp Plant	Bonzi	200 x 1	
		Bonzi	Less than 10 x 1 (drench)	
<i>Pentas lanceolata</i> 'Orchid Illusion' 'Lavender' 'Red'	Pentas	B-Nine	5000 x 3	'Orchid Illusion' more sensitive to B-Nine; 'Red' less sensitive to B-Nine
		B-Nine/Cycocel	1500/ 1500 x 1	
		Bonzi	Greater than 45 x 1	
		Bonzi	Greater than 16 x 1 (drench)	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Perovskia atriplicifolia</i>	Russian Sage	B-Nine	multiple @ 5000	Delayed flowering. Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Greater than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
		Florel	500 x 2	Delayed flowering.
		Sumagic	15 to 30 x 1	
<i>Phlox paniculata</i> 'Bright Eyes'	Garden Phlox	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
<i>Phlox paniculata</i> 'Blue Boy' 'Charles Curtis'	Garden Phlox	B-Nine	NR @ 5000 x 2	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/4000 x 1	Multiple applications required.
		Bonzi	NR @ 160 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	NR @ 60 x 1	
<i>Phlox paniculata</i> 'David'	Garden Phlox	B-Nine	5000 x 2	Moderate control. Apply at 10-14 day intervals.
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Sumagic	60 x 1	
<i>Phlox paniculata</i> 'Joliet'	Garden Phlox	B-Nine	NR @ 5000 x 2	
		Bonzi	NR @ 240 x 1	
		Sumagic	Greater than 80 x 1	Persistent reductions in plant growth continue in the landscape at 80 ppm.
<i>Phlox paniculata</i> 'Mt. Fuji'	Garden Phlox	Florel	NR @ 1000 x 3	
<i>Phlox paniculata</i> 'Eva Cullum'	Garden Phlox	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
<i>Physostegia virginiana</i> 'Summer Snow'	Obedient Plant	A-Rest	NR @ 100 x 7	
		B-Nine	NR @ 5000 x 4	
		Bonzi	NR @ 100 x 1, NR @ 30 x 7	
		Cycocel	NR @ 1500 x 7	
		Florel	500 x 3	Delayed flowering.
		Sumagic	NR @ 15 x 7	For 'Alba': 25 x 1 drench was effective.
<i>Platycodon grandiflorus</i> 'Fuji White'	Balloon Flower	Bonzi	Greater than 50 x 1	
		Bonzi	Greater than 1.5 x 1 (drench)	
<i>Polemonium caeruleum</i>	Jacob's Ladder	B-Nine	Greater than 2500 x 1	Apply at 10-14 day intervals.
		B-Nine/Bonzi	2500/15 x 1	
		B-Nine/Cycocel	2500/1500 x 1	
		Bonzi	Greater than 15 x 1	
<i>Rudbeckia fulgida</i> var. <i>sullivantii</i> 'Goldsturm'	Black-eyed-Susan, Orange Coneflower	B-Nine	NR @ 5000 x 4	
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Greater than 160 x 1 or Greater than 30 x 4	
		Bonzi	Greater than 30 x 1 (drench)	
		Cycocel	NR @ 4000 x 1	
		Sumagic	30 x 1	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Rudbeckia triloba</i>	Three-lobed Coneflower	B-Nine	5000 x 2	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	80 x 1	Multiple applications required.
		Cycocel	2000 x 1	No phytotoxicity noted; multiple applications may be required.
		Sumagic	30 x 1	
<i>Salvia farinacea</i> 'Victoria Blue'	Mealy-cup Sage	B-Nine	NR @ 5000 x 1	
		Bonzi	48 to 64 x 1	
		Florel	500 to 750 x 1	
		Sumagic	5 to 15 x 1	
<i>Salvia greggii</i>	Texas Sage	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Greater than 6 x 1 (drench)	
		Sumagic	Less than 15 x 1	No landscape persistence at 15 ppm.
<i>Salvia leucantha</i>	Velvet Sage, Mexican Sage	B-Nine	5000 x 3	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	60 x 1	
		Cycocel	2250 x 1	
		Florel	500 x 1	
		Sumagic	30 x 1	No landscape persistence at 30 ppm.
<i>Salvia x sylvestris</i> 'Blue Queen'	Hybrid Sage	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1000 x 1	Excessive height reduction. Test B-Nine concentration at 2500 ppm.
		Bonzi	Greater than 30 x 4 120 x 1 Greater than 30 x 1 (drench)	
		Sumagic	Greater than 60 x 1	Multiple applications may be required.
<i>Salvia x sylvestris</i> 'May Night'	Hybrid Sage	B-Nine	5000 x 2	
		Florel	250 to 1000 x 1	Some delay in flowering with eventual increase in inflorescence numbers.
		Sumagic	NR @ 20 x 1	
		Bonzi	NR @ 160 x 1	
<i>Saponaria ocymoides</i>	Rock Soapwort	Cycocel	NR @ 4000 x 1	
<i>Scabiosa caucasica</i> 'House Hybrids'	Pincushion Flower	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Bonzi	NR @ 160 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	NR @ 60 x 1	
<i>Scabiosa columbaria</i> 'Butterfly Blue'	Pincushion Flower	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	NR @ 5000/1500 x 1	
		Florel	250-750 x 1	Higher rates delay flowering.
		Sumagic	20 x 1	
<i>Sedum x</i> 'Autumn Joy'	Autumn Joy Sedum	B-Nine	5000 x 2	Moderate control. Apply at 10-14 day intervals.
		B-Nine/Bonzi	Greater than 2500/40 x 1	
		B-Nine/Cycocel	5000/1500 x 1	Moderate control
		Bonzi	80 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	15-30 x 1	Persistent reductions in plant growth continue in the landscape.

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Sedum spurium</i> 'Dragon's Blood'	Two Row Stonecrop	B-Nine	NR @ 5000 x 4	
		Bonzi	Greater than 30 x 4	
		Bonzi	30 x 1 (drench)	
<i>Solidago sphacelata</i> 'Golden Fleece'	Golden Rod	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		Bonzi	80 to 100 x 1	Persistent reductions in plant growth continue in the landscape with rates above 100 ppm.
		Bonzi	Greater than 30 x 1 (drench)	
		Sumagic	Less than 30 x 1	Persistent reductions in plant growth continue in the landscape with 30 ppm.
x <i>Solidaster luteus</i> 'Tara'	Golden Aster	B-Nine	Greater than 2500 x 1	
		B-Nine/Bonzi	Greater than 2500/40 x 1	
		B-Nine/Cycocel	Greater than 2500/1500 x 1	
		Bonzi	Greater than 40 x 1	
<i>Stokesia laevis</i> 'Klaus Jelitto'	Stoke's Aster	B-Nine	5000 x 2	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	Moderate control. Apply at 10-14 day intervals.
		Sumagic	NR @ 60 x 1	
<i>Stokesia laevis</i> 'Purple Parasols'	Stoke's Aster	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/2250 x 1	
		Bonzi	40-80 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	NR @ 60 x 1	
<i>Verbena bonariensis</i>	South American Verbena, Tall Verbena	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		Bonzi	120 to 160 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	30 to 45 x 1	Persistent reductions in plant growth continue in the landscape.
<i>Verbena canadensis</i> 'Homestead Purple'	Clump Verbena	B-Nine	NR @ 5000 x 2	
		B-Nine/Cycocel	5000/1500 x 1	Multiple applications may be required.
		Bonzi	Greater than 3 x 1 (drench)	
		Florel	500-1000 x 1	High rates delay flowering.
<i>Veronica alpina</i> 'Goodness Grows'	Alpine Speedwell	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Less than 240 x 1	Test rates below 240 ppm.
		Sumagic	Less than 15 x 1	Persistent reductions in plant growth continue in the landscape at 15 ppm.
<i>Veronica peduncularis</i> 'Georgia Blue'	Veronica Speedwell	B-Nine	Greater than 2500 x 1	Apply at 10-14 day intervals.
		B-Nine/Bonzi	2500/7.5 x 2	
		Bonzi	Greater than 15 x 1	

Crop	Common Name	Product	Spray Rate (ppm) x No. Applications*	Precautions & Remarks
<i>Veronica spicata</i> 'Blue'	Spike Speedwell	B-Nine	5000 x 4	Apply at 10-14 day intervals.
		Bonzi	Greater than 30 x 4	
<i>Veronica spicata</i> 'Red Fox'	Spike Speedwell	B-Nine	multiple @ 5000	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 2	
		Bonzi	Less than 40 x 1	
		Cycocel	NR @ 4000 x 1	
		Sumagic	Less than 15 x 1	
<i>Veronica x</i> 'Sunny Border Blue'	Hybrid Speedwell	A-Rest	Less than 100 x 3	Reduce rate or frequency.
		B-Nine	5000 x 2	Apply at 10-14 day intervals.
		B-Nine/Cycocel	5000/1500 x 1	
		Bonzi	Much less than 40 x 1	Very sensitive to Bonzi. Test rates below 20 ppm.
		Bonzi	Greater than 30 x 1 (drench)	
		Cycocel	750-1500 x 1	
		Sumagic	Less than 15 x 1	Very sensitive to Sumagic. Persistent reductions in plant growth continue in the landscape at 15 ppm.

NR = non-responsive at rates listed

*Rates given are for spray applications at label recommended volumes unless stated otherwise. Not all uses listed are on the label. Check product label before using.

*PGRs are not labeled for use on edible herbs. Specify for ornamental use only.

Recommended Resources

Solution Calculations. For a ready resource on preparing PGR solutions, download the North Carolina State University Plant Growth Regulator Calculator from:

<http://www.ces.ncsu.edu/depts/hort/floriculture/software/pgr.html>

This Microsoft Excel spreadsheet 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 spreadsheet 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, but also provides the cost of the application based on the area or number of containers treated.

Updated Research Information. For regularly updated research information on using PGRs on perennials, visit a searchable database of the information in Table 1 on the Scranton-Gillette Communications/Greenhouse Product News web site:

www.sgcpubs.com/onhort/index.cfm?fuseaction=showpgrsearchform

Appendix. Helpful conversions.

Volume

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

1 fl oz = 30 milliliters (ml)

1 gal = 3785 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

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