Using PGRs for Early Control of Plant Growth and Development

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

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

PGRs – Deciding What and When to Apply

PGRs are most effective when applied at the appropriate times to regulate plant growth or development. When planning PGRs in your production schedule, consider what you want to accomplish with the treatment.

Branching enhancers. Using a PGR that functions as a branching enhancer to improve plant architecture must be done before the plant architecture is fully formed. These PGRs are frequently called “chemical pinchers” because they generally inhibit the growth of the terminal shoots or enhance the growth of lateral buds, thereby increasing the development of lateral branches. These branching enhancers include: ethephon (Collate, Fine Americas; Florel, Monterey Chemical), BA or benzyladenine (Configure, Fine Americas), dikegulac sodium (Augeo, OHP), and methyl esters (Off-Shoot-O, Cochran Chemical).

Branching enhancers can be used to replace mechanical pinching of many crops like Verbena and Lantana. Often this increased branching also will reduce the overall height of the plant. If you are looking for enhanced branching, you must have sufficient growth on the plant to allow for sites of lateral development. They cannot enhance lateral branching if there are no lateral buds on the plant. Timing of the application is critical to a good branching response. As we will describe below, earlier applications are beneficial for many crops.
**Growth retardants.** Most of the PGRs used in the greenhouse or nursery are used to regulate shoot growth of containerized crops. These PGRs are referred to as “growth retardants.” Typical growth retardants are daminozide (B-Nine, OHP; Dazide, Fine Americas), chloromequat chloride (Citadel, Fine Americas; Cycocel, OHP), ancymidol (Abide, Fine Americas; A-Rest, SePRO), flurprimidol (Topflor, SePRO), paclobutrazol (Bonzi, Syngenta; Downsize, Greenleaf; Piccolo, OHP; Piccolo or Piccolo 10 XC, Fine Americas) and uniconazole (Concise, Fine Americas; Sumagic, Valent).

Generally, growth retarding PGRs should be applied just prior to rapid shoot growth. Remember that growth retardants cannot “shrink” an overgrown plant. They must be applied before the plant is overgrown to avoid plant stretch. This is generally one to two weeks after transplanting a plug, after the roots are established and as the plant resumes active growth. On pinched plants, it is after the new shoots are visible and starting to elongate. This is where the art of plant growth regulation is most important. You must learn how your crop grows and when to intervene to obtain the desired results.

**Early Application of Branching Enhancers**

**Research with Configure.** Our initial research with branching enhancers focused on applications of Configure (BA) to herbaceous perennial plants after establishment in their finished containers, about 2 weeks after plugs/liners were planted (Latimer et al., 2011). Subsequent work with *Echinacea* ‘White Swan’ found that treatment with 600 ppm Configure at the time of, or within a week of, potting liners resulted in earlier pot fill and a persistent improvement in finished plant branching (M. Aiken, unpublished work). This started our quest to determine the value of earlier BA applications and we started working with treatments during rooting and finishing of the liners.

Unrooted cuttings of a variety of herbaceous perennial crops were dipped in 1500 ppm IBA and stuck into 72 size plug trays filled with a peatlite media. Cuttings were rooted under mist with bottom heat at 72°F. Several crops, including *Agastache* ‘Tutti Frutti’ and *Verbena bonariensis* were tested for timing of the BA application, starting with application prior to sticking cuttings. There were clear indications that although optimal application time varies with crop and time of year, applications are best made after cuttings have developed roots but before the roots have filled the cells in the liner tray (Grossman et al., 2014).

Therefore, in our herbaceous perennial liner trials, Configure (or Augeo in some trials) was applied as a foliar spray when roots from cuttings were evident on all four sides of the root ball, but liners were not fully rooted and ready for transplant (18 to 34 days after sticking). Typically this was just after the liners were removed from mist. Finished liners were evaluated 2 to 3 weeks after treatment and then potted for evaluation of the finished plants (3 to 4 weeks later).

**Results with Configure.** A wide variety of herbaceous perennials were responsive to Configure which enhanced liner quality with increases in the numbers of lateral or basal branches in most crops and in some cases increased numbers of leaders or shoot dry weight, e.g., *Lavandula x intermedia* ‘Provence’ (Figure 1). In other words, treatment of liners with Configure resulted in
larger liners that may finish more quickly. In some crops, like *Gaura lindheimeri* ‘Siskiyou Pink’ or *Lavandula* ‘Provence’, the increase in branching of the liners resulted in finished plants with a greater number of branches than untreated plants (Grossman et al., 2011).

![Figure 1. Configure applied to liners at 34 days after sticking increased the number of shoots and lateral branches as well as shoot dry weight of *Lavandula* ‘Provence’; untreated, 300 ppm applied once, 300 ppm applied twice, 600 ppm applied once (left to right). Picture taken at four weeks after treatment.](image)

We also found that multiple applications of Configure on responsive crops significantly enhanced finished plant quality with the first application during liner production as described above which was then followed by a second application 3 to 5 days after transplanting to the final container. For crops responsive to Configure, there was a significant increase in branching of finished plants with an additional application shortly after transplanting, e.g., *Achillea, Gaura, Nepeta, Sedum*, and *Phlox* (Grossman et al., 2013).

**Recommendations for Configure.** Apply foliar sprays of Configure at 300 to 600 ppm to rooted liners shortly after removal from mist. As with all new applications, test Configure for phytotoxic responses on new crops. Reapply Configure to the plants shortly after transplanting liners to finished containers. If you are not rooting your own liners, you can still use this principle by treating your liners shortly after arrival – as long as they are actively growing – and then treat again two weeks later. *The interval between the applications of Configure MUST be at least two weeks to avoid potential phytotoxicity.*

**Results with Augeo (dikegulac sodium).** Similar studies were conducted with fewer crops using spray applications of Augeo at 400, 800, or 1600 ppm as the branching enhancer. Augeo tends to cause more of growth regulation than does Configure. *Veronica spicata* ‘Goodness Grows’
was sensitive to Augeo with all rates increasing branching (control 1.0 vs. 400 ppm treated 8.0 branches) of the finished liners; however, multiple applications at the higher rates tended to cause stunting of the finished plants (Grossman et al., 2013). Augeo at 400 ppm doubled the number of branches on Sedum ‘Autumn Joy’ liners compared to untreated liners without reducing growth or causing chlorosis of the leaves; however, when two applications of 400 ppm Augeo were made, finished plants had twice as many leaders and nearly three times as many branches as untreated plants (Latimer et al., 2013). Note: finished plants from two applications of Augeo were slightly lighter in color at finish than were untreated plants. Apply Augeo as early as possible in the crop cycle to allow time for plants to green up.

In some crops, like Sedum above or Nepeta ‘Walker’s Low’, growth regulation is a beneficial side effect of using Augeo. However, in some crops, like Achillea ‘Moonshine’, Nepeta ‘Walker’s Low’, or Phlox ‘Bright Eyes’, two applications of Augeo at rates sufficient to increase branching also caused excessive growth reduction of the finished plants (Grossman et al., 2013).

### Early Applications of Plant Growth Retardants

**Spray Applications.** Typically PGRs have been applied as foliar sprays. However, the commonly used growth retardants are actively taken up by root systems, i.e., they are soil active. Therefore, applications via drenches, drip irrigation or subirrigation are becoming more popular, especially with larger crop producers. In all cases, plants to be treated with PGRs should be healthy, turgid and unstressed – never wilted. The label will identify the application methods for that PGR. For example, daminozide is only effective as a foliar spray whereas paclobutrazol and uniconazole sprays are effective through contact with the stems, petioles and the growing substrate (via root uptake).

**Liner soaks** or drenches are another specialized way to apply soil active growth retardants that provides early control in a relatively safe application method. The root system of rooted liners or plugs is dipped into a solution of the PGR (or they may be thoroughly drenched in the plug tray). Extensive work conducted at the University of Florida identified these guidelines on this application method (Schnelle et al., 2005):

- Liners should be “dry” which is defined as the root ball being ready for irrigation, but not under drought stress.
- Time in the solution is not critical; 30 sec to 2 minutes is sufficient for saturation of the rootball.
- Liners may be planted immediately or held up a few days without loss of PGR effect.
- There is no loss of effectiveness of the dip solution during treatment.

Advantages of liner soaks include the early growth control of vigorous crops, ease of application and avoidance of restricted entry interval (treat one day and plant the next). Liner soaks should be planned to provide early and “baseline” control. In other words, the control should not be intended to last the entire production season. If conditions are less than ideal, you don’t want stunted plants. You can always make additional growth retardant applications if necessary. However, another excellent use of liner soaks is to control the growth of vigorous plants in
mixed baskets or containers. Since only the root balls of the vigorous plants are treated, only those plants are regulated.

**Rudbeckia ‘Goldsturm’ Liner Soak Example.** *Rudbeckia* ‘Goldsturm’ is still a major summer flowering perennial for most growers but growth management may be necessary, especially in quart production. With late spring plugs, these plants begin to stretch as soon as flowers are initiated. We evaluated crop response to uniconazole (Concise, Fine Americas, Inc.) applied by different methods. **Warning:** these Concise (uniconazole) concentrations are considered Southern application rates, so adjust your application rates down for more northern areas.

All of the experiments presented here were performed using plugs from the same lot and shipment date (Week 17). We tested liner dips of Concise on some of these *Rudbeckia* ‘Goldsturm’ plugs. The rootballs of the plugs were soaked in a Concise solution of 0, 1, 2, 3, 4, or 5 ppm for 30 seconds. The plugs were potted the following day into quart (1.1 liter) pots filled with a peat-lite medium. Plants were fertigated with 200 ppm N (Peter’s 20-10-20). The liner soaks were very effective at controlling stem elongation (Figure 2).

![Figure 2. Rudbeckia ‘Goldsturm’ treated with 30-second liner soaks of Concise at 0, 1, 2, 3, 4, or 5 ppm (left to right) the day before potting. Top photo taken at 6 weeks after treatment. Bottom photo taken at 10 weeks after treatment.](image)

**What about the effects on flowering?** Although all plants set flower buds about the same time, at the higher concentrations the liner soaks delayed flower opening of *Rudbeckia* ‘Goldsturm.’ Furthermore, when those flowers opened, the flower stalks did not extend above the foliage. So, while liner dips offer a rapid and early application method for the soil-active growth
regulators, you must select appropriate concentrations. In the South, 1 ppm Concise gave moderate control throughout the production period, did not delay flowering, and maintained reasonable plant balance with the quart pot.

**Spray applications were also tested** using plugs from this same lot and shipment date. Plugs were potted at the same time as those treated with liner dips but the treatments were applied one week later. For spray applications Concise was applied one time at the label recommended volume (1 gallon per 200 square feet) at 0, 15, 30, 45, or 60 ppm.

The higher spray concentrations of Concise, 30 to 45 ppm, were required to give adequate control of *Rudbeckia* ‘Goldsturm’ after flower initiation (Figure 3). Flower opening was slightly delayed by 45 ppm but for a quart program, this rate provided better balance. For trade gallon or larger programs, use rates closer to 30 ppm Concise for spray applications.

![Figure 3. Rudbeckia ‘Goldsturm’ treated with spray applications of 0, 15, 30, 45 or 60 ppm Concise (left to right) one week after potting. Photo taken at 8 weeks after treatment which was 9 weeks after potting.](image)

In summary, *Rudbeckia* ‘Goldsturm’ is very responsive to Concise (uniconazole). Early application as liner soaks improved plant form and flower display in the quart pot program. Liner soak solution concentrations should not exceed 1 ppm. Spray applications of Concise required rates of 30 to 45 ppm to maintain control throughout the production period and provide a reasonable plant balance at flowering.

*As always, test these products and rates on a small number of plants in your own operation before treating large numbers of plants. Refine the treatments to suit your application and growing conditions.*

**Summary**

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

The multitude of variations possible in application methods, cultivar and species grown, and growing conditions make it impossible to recommend specific rates for all operations. Use the product labels and PGR guides listed below as a resource for the use of PGRs on a variety of crops. Generally, you should use the lower of suggested effective rates for starting your own trials.

There are a couple of general rules for using rate recommendations from other sources:

- Southern growers use higher rates and more frequent applications than Northern growers. Rates for Virginia/Maryland tend be closer to the Southern rates.
- Outdoor applications usually require higher rates or more frequent applications than for plants grown under cover.

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

**Resources** – look for these and other PGR resources at [http://e-gro.org/research.php](http://e-gro.org/research.php)


**Literature Cited**


