



RESEARCH NEWSLETTER



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Using Ethylene-Releasing PGRs for Hyacinth and Narcissus Height Control

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Over the last few years, we have been experimenting with the idea of applying ethylene-releasing plant growth regulators (PGRs) to the rootzone as a substrate drench. This is a rather radical idea for floriculture production overall and flowerbulb forcing in particular. In this newsletter, we'll review ethylene as a growth regulator, discuss the commercially available ethylene-releasing PGRs and show a number of examples of such drenches on daffodil and hyacinth.

Ethylene

Plants produce and react to, a number of chemicals we refer to as "plant hormones". These hormones, or "plant growth substances" regulate many aspects of plant growth and development. For example, auxins such as IAA, NAA, IBA, etc. are important for adventitious rooting of cuttings and inhibiting bud growth in growing shoots. Gibberellins (there are more than 125 known) are important for cell elongation and bud growth and some of them are very important for reducing leaf yellowing and increasing flower longevity in lilies. Cytokinins are important in cell division, especially in tissue cultures and micro-propagation. Abscisic acid regulates water loss from leaves and is often involved in dormancy. Ethylene is critical for flower senescence, fruit ripening and for aiding seedlings to emerge from the soil. Finally, there are a number of other hormones and hormone-like chemicals that will not be considered here.

Ethephon: an ethylene releasing PGR


Ethephon (2-chloroethylphosphonic acid) is a chemical that breaks down into ethylene, phosphate and a chloride ion. It is therefore very safe and is a truly "environmentally friendly" PGR. All formulations of ethephon (see below) come as liquids that are typically diluted and sprayed on the plant. Ethephon is a weak acid, and when sprayed on the plant, due to the relatively high pH of most plant tissues (close to pH 7), it spontaneously breaks down into ethylene, chloride ion and phosphate



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ion. There is no metabolism involved, it is a spontaneous reaction due strictly to pH. Once sprayed, the ethephon is converted to ethylene over a period of several days.

Ethephon in horticulture and agriculture

Ethephon is available as a number of products in the horticulture industry. For example, Ethrel and Motivate (21.7% active ingredient liquids) are used on many crops including apples, tart cherries, tomatoes, grapes and raisins, walnuts, peppers, blackberries, blueberries, cantaloupes and other crops. Other formulations of ethephon in agriculture include Prep (in cotton) and Cerone (for reduction of “topple” in grain crops) that are used on a wide variety of crops worldwide. In the US and Canada, ethephon is available as Florel (a 3.9% a.i. liquid) or Pistill (a different brand name). In the last 12 months, Collate (21.7% a.i. from Fine Americas) has become available in the US and is labeled for ornamentals use, specifically for increasing branching, for fruit elimination in trees and shrubs, to induce flowering in bromeliads, mistletoe removal, and height control in daffodils and hyacinths, among other uses.

Ethylene in bulb forcing

Ethylene-releasing chemicals are important for height control in narcissus and hyacinth. Many years ago, Gus de Hertogh developed recommendations for ethephon (as Pistill or Florel) as a foliar spray for daffodils and hyacinths. The desired effect from a Florel spray is shorter leaves and stems with no effect on flower size, number, life, etc. Florel is generally useful on hyacinths and daffodils, and Gus’ extensive work resulted in cultivar specific recommendations that are long available in the Forcers Guide (we are working to get that information onto our website at www.flowerbulbs.cornell.edu). For height control, Florel sprays (at concentrations of 500-2,000 ppm or mg/liter, one or two sprays, depending on cultivar and time of year) are made when plants are 3-4” tall and when hyacinths have some leaves unfolding, before stem elongation and before buds are showing in narcissus (see Fig. 1 and 2 from the Forcer’s Guide).

It happens that ethephon spray applications are not always effective for potted hyacinth or narcissus height control. There are several potential reasons for this. Ethephon effectiveness is influenced by temperature, concentration, humidity and likely several other factors. It has also been speculated that the chemistry of the water used to mix the solution (the “water quality”) might be involved, since high pH waters should increase faster ethylene release from the ethephon before the spray is applied.

Another simple reason might be the stage of plant growth when the spray is applied. At the correct stage (Figs. 1 and 2), there is adequate leaf and flower bud surface to absorb the spray so it can be active. It seems reasonable that if sprays are applied earlier, less leaf surface is available for absorption, and therefore less effect might be the result.

Ethephon drenches: A new concept for Hyacinth and Narcissus forcing

Starting in the 2011 forcing season, we began evaluating ethephon drenches for hyacinth and daffodil height control. The spark for this was a visit to Cornell of Erik Runkle from Michigan State University in spring 2010. As we were looking at our trials in the greenhouse, we began discussing growth regulators, and how ethephon is unique: it is widely used in floriculture as a spray, but apparently not as a drench. This is unlike many other PGRs (for example, Bonzi, Sumagic, Topflor) that can be used effectively as sprays or substrate drenches. We pondered this, and set up a small experiment by placing some planting mix into a jar, adding some Florel, and measuring the ethylene that was released into the sealed jar over time. To our surprise, the ethylene slowly accumulated over time, in fact over a period of several days. This was the moment we realized that the soil mix could actually act as a “controlled release system” for ethylene, and that this could be really useful for spring bulbs that respond to ethylene, namely daffodils and hyacinths.

So, what's new with ethephon drenches and bulbs?

In the last 3 forcing seasons, we have conducted many experiments on ethephon as a substrate drench. We initially worked with Florel but after Fine Americas signaled they were interested in developing a new ornamentals product, and (hopefully) with label clearance for substrate drenches, we began to use Collate (the Fine Americas version of ethephon) exclusively. Our results indicate both products function equally at identical concentrations.

General procedures. In the experiments highlighted here, we planted bulbs into 6" (15 cm) pots, with Lambert LM-111 planting mix and cooled. After plants were brought into the greenhouse in the spring, drenches were applied when plants were 3-4" tall, using 120 ml (4 ounces) per pot, which is a common volume for PGR applications to pots. Depending on the experiment, plants had 16-18 weeks of cold. We have mainly used the new product, Collate, as the ethephon source. Earlier experiments in 2010 and 2011 were with Florel.

Concentration and cultivars. A number of cultivars of narcissus and hyacinth have been evaluated for response to Collate drenches. For daffodils, we have worked mostly in the range of 100 to 500 ppm drench concentration. Hyacinths are usually a little higher, up to 600 ppm. The result we consistently see across both species and many cultivars is shorter leaves and stems with less leaf and stem flop. There is sometimes a couple of days delay in flower time, especially at the highest rate. There is no effect on flower size, color or longevity. Importantly, Collate drenches *reduce postharvest leaf and stem stretch* which is a very important component of plant quality in the retail and home environment.


For most daffodil cultivars, the 500 ppm rate is usually too high, and the 100 ppm rate is sometimes too low (Fig. 3). This overall rate response is remarkably similar across cultivars, and we generally believe that a starting concentration range of 200-250 ppm Collate is appropriate for most cultivars.

We have seen some ill effects, however, notably reduced number of flower stems in Tete-a-Tete, especially from early applications. We have also seen flower blasting in experiments with very late flowering double cultivars that were treated at the same time as earlier flowering cultivars. Thus, there is some danger with too-early application of ethephon to daffodils, and growers will need to gain some experience prior to large scale application. Our thinking is that late cultivars or multi stem cultivars have flower buds and stems still deep in the soil when some of the leaves are 3-4" long, and the ethylene must have a very powerful effect on these late emerging stems.

For hyacinths, it seems a slightly higher concentration is needed, possibly in the 300-350 ppm range (Fig. 4).

Effect of ethephon drench volume. The volume of drench used has a large effect on plant response. When using a constant concentration of 250 ppm ethephon, increasing the volume of drench from 1 to 4 ounces per pot gave a larger effect (Fig. 5). This makes sense, as the *dose of ethephon* increases as drench volume goes up. In this case, the *dose per pot* resulting from 0, 1, 2, 3 or 4 ounces of 250 ppm Collate is 0, 7.5, 15, 22.5 and 30 mg/pot, respectively. Thus, an increasing response from an increasing volume of drench is logical. The point here is that a dose of 30 mg ethephon per pot is good for most narcissus cultivars.

Effect of a constant ethephon dose per pot. The *dose per pot* is the product of the volume per pot and the concentration. So, a 30 mg ethephon could be given to a pot by high volume and low concentration, or by high concentration and low volume. We have done several experiments showing that final narcissus height is constant if plants are given a constant dose per pot in different ways. For example, Figure 6 shows Primeur daffodils treated with 30 mg ethephon per pot by applying a range of drench volumes and concentrations. You can see that whether treated with a high volume-low concentration, or low volume-



high concentration, all treated plants are the same height since each received the same dose of ethephon. This is a very important finding as it means automated technologies, such as moving booms, could be employed to treat plants with ethephon. A high volume, relatively low concentration drench is not necessary...a higher concentration “sprench” should work just as well.

Effect of spray volume and concentration. Given a constant drenched dose of ethephon per pot produces similarly sized plants, would the same hold true if the ethephon were sprayed at various concentrations and spray volumes? In fact, high volume sprays, at some moment, are simply drenches, if enough spray volume is applied per unit bench area. Figure 7 shows this is indeed the case. If we sprayed ethephon using different volumes of varying spray concentrations to give about 30 mg/pot per treatment, we obtained the same growth reduction effect. So, essentially our work shows ethephon can be applied by individual pot drench, or by a moderate to high volume spray (“sprench”) at the appropriate *dose* to give good height control.

Ethephon sprays of 1,000 to 2,000 ppm have been suggested historically for narcissus. Assuming a “typical” spray volume common in the industry, which is 2 quarts/100 sq. ft. and that pot-to-pot, 36 6” pots fit in a square yard, it can be calculated that each pot should receive about 5 to 10 mg ethephon/pot when sprayed with 1,000 or 2,000 ppm ethephon. The examples given in this report are showing excellent height control with 30 mg ethephon/pot, applied by a drench or sprench, quite a bit more than in the Forcer’s guide. This may help explain inconsistent ethephon effects for some growers. In some cases, growers might be applying heavy sprays, way past runoff, and others might be spraying “lightly”. Since these would vary the dose per pot, the growth retardation effect would also be variable.

Economics

For a 6” pot, assuming a Collate cost of \$45/liter at a concentration of 21.7% and a drench of 250 ppm applied in a volume of 4 ounces, the material cost to treat one pot is about \$0.0062 per pot (about 0.6 cents). This is an excellent bargain, and significantly less expensive than other options such as Bonzi or Topflor preplant dips or drenches.

Concluding thoughts

As a starting point, for 6” pots, 200-250 ppm drenches with 120 ml drench solution per pot gives good results on many narcissus cultivars when applied at the stage in Fig. 1. For hyacinths, starting concentration of 300-350 ppm would be logical, applied at the stage in Fig. 2. Our work evaluating dosage per pot, whether given through drench volume/concentration changes, or spray volume/concentration changes, suggests there should be a wide variety of methods to apply ethephon as drenches, sprenches or heavy sprays in potted narcissus and hyacinth production. It is important to note that, at the present time (winter, 2014), there is no ethephon product specifically labeled for such high volume drenches. We are hopeful this situation will change by the start of the 2015 forcing season.

A final word of caution. The ethylene released by ethephon is indeed a powerful growth regulator. We have noted that it can cause direct damage including failed flowering and blasted flowers in narcissus under some circumstances. And, many plants can be severely injured by ethephon. For example, we have already tried ethephon drenches on Easter lilies...not a good idea as most of the flowers blasted and did not open. Even so, it is likely that ethephon drenches will become mainstream in the floriculture world on certain crops where it is beneficial. Now, if we could only make this work for tulips

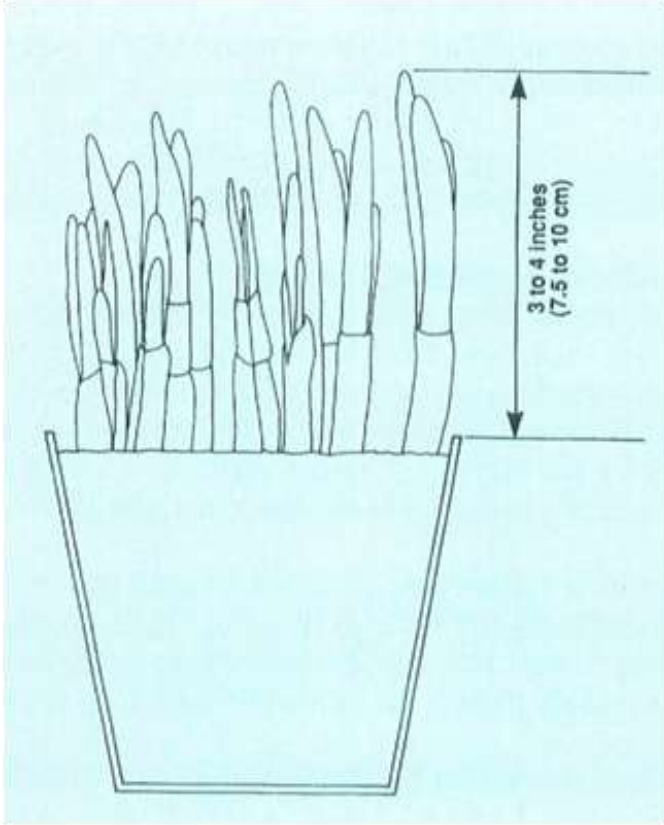


Figure 1. Stage of development of narcissus for spraying ethephon (Collate or Florel) for height control. Image from the Holland Bulb Forcer's Guide.

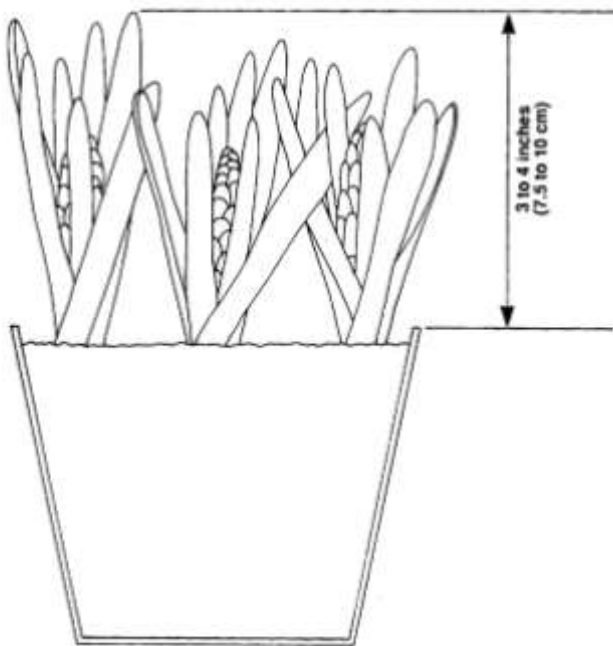


Figure 2. Stage of development of hyacinth for spraying ethephon (Collate or Florel) for height control. Image from the Holland Bulb Forcer's Guide.



Figure 3. Effect of ethephon drench concentration on Flower Parade, Ice Follies and Primeur. Left to right: Control, 100, 250 or 500 ppm ethephon drench, giving 15, 30 or 60 mg ethephon/pot. 17- 18 cold weeks. Images 8105, 2448, 2297.



Figure 4. Effect of ethephon drench concentration on Delft Blue, Splendid Cornelia or Aiolos hyacinths. Left to right: Control, 150, 300, 450, 600 ppm ethephon drench, giving 18, 36, 54 and 74 mg ethephon/pot. 16-18 cold weeks. Images 0612, 0618 and 8076.



Fig. 5. Effect of drench volume (using 250 ppm ethephon) on growth of Primeur and Tete-a-Tete daffodils in 6" pots. Drench volumes were L to R: 0 (untreated), 30, 60 90 or 120 ml (1, 2, 3, 4 ounces), giving doses of 0, 7.5, 15, 22.5 and 30 mg ethephon/pot. 17 cold weeks. Primeur: Early in flowering (top) and at the end of flowering (middle). Tete-a-Tete, end of flowering (bottom). Images 7955, 8068, 7889.



Figure 6. Effect of constant doses of ethephon delivered by varying concentration and drench volume per pot on Primeur. L to R: Control (untreated), or drenched with 30, 60, 90 or 120 ml of 1,000, 500, 333, or 250 ppm Collate, each dose equal to 30 mg ethephon/pot. 17 cold weeks. Image 8112.



Figure 7. Effect of constant doses of ethephon delivered by spraying different concentrations and spray volumes (per 1 square meter bench area) on Primeur narcissus. L to R: Control (untreated) or sprayed with ethephon (per square meter) as follows: 210 ml of 6,000 ppm, 420 ml of 3,000 ppm, 840 ml of 1,500 ppm, and 840 ml of 750 ppm Collate, giving approximately 0, 30, 30, 30, and 15 mg ethephon per pot. 17 cold weeks. Image 8080.