A New Height Control Possibility *for* Daffodils *and* Hyacinths

A NEW DRENCH TECHNIQUE SHOWS PROMISING RESULTS WHEN USED ON BULBS.

By William Miller, Neil Mattson, Roberto Lopez, Christopher Currey, Kasey Clemens, Michael Olrich and Erik Runkle

In floriculture, we have long been familiar with Florel sprays, whether for height control on hyacinths or daffodils, to abort flowers and promote of branching in many crops (such as geraniums and fall mums), or to induce flowering in bromeliads.

Chemically, Florel is ethephon or (2-chloroethyl) phosphonic acid and is sold as a 3.9 percent active ingredient liquid. It is stable in acidic solutions for a relatively long time. At higher pH, the molecule decomposes chemically to release ethylene gas, and chloride and phosphate ions. Ethylene begins to release from ethephon at about pH 6 with faster release as pH increases to 8 or more. Therefore when mixing a spray tank, growers should initially use water low in pH or use a pH reducer. When sprayed on plants, ethylene release is promoted by the relatively high pH of leaf and stem cells (probably close to a pH of 7).

The earliest widely used plant growth regulators (PGRs), B-Nine and Cycocel, were mainly applied as foliar sprays and typically sprayed to "runoff." At least with B-Nine, there was little to no activity when these materials were applied to the growing substrate. When the triazole PGRs first came on the market (pacloburazol [for example, Bonzi, Piccolo, Paczol]) and uniconazole [for example, Sumagic, Concise]), growers also used them in the "spray to runoff mode," and the results were massively stunted plants.

Eventually it was realized that the effect of a spray application of paclobutrazol or uniconazole is really the result of the combined absorbance by leaves, stems and roots. The relative proportion of these is greatly influenced by spray volume, where a spray to runoff allows material to run into the substrate, where some root uptake can happen. A heavy spray also gives a small drench effect, and smaller plants are the result. Thus, for spray applications, we now think in terms of volume of PGR per bench area.

In the case of daffodils (narcissus) and hyacinths, Florel sprays have long been the mainstay height control technique, and specific guidelines are available through the Holland Bulb Forcer's Guide and the website of the Flower Bulb Research Program (www.flowerbulbs.cornell.edu). In the case of other uses in floriculture, Florel has always been used as a spray and has never been used as a drench material.

But if it was, what would be the result? Ethephon (Florel) exerts a growth effect when it decomposes into ethylene in the plant. Would ethylene even be formed if it was applied as a drench into our relatively low pH, peat-based substrates? And, if ethylene was released, would there be any effect on the plant? Would there be any side effects? Might your greenhouse fill up with ethylene and kill all your plants? These are the questions we were asking when we started working on Florel drenches two years ago at Cornell, Michigan State and Purdue. We first looked into whether ethylene would be released from Florel substrate drenches in soilless substrates, and how Florel drenches would affect hyacinths, daffodils, and a variety of bedding plants.

Table 1. pH of sphagnum peat amended with 0-20 lb/yd^3 of dolomitic lime.

Lime (lb/yd^3)	pH
0	3.9
2	4.6
4	5.1
8	6.5
12	6.9
16	7.1
20	7.3

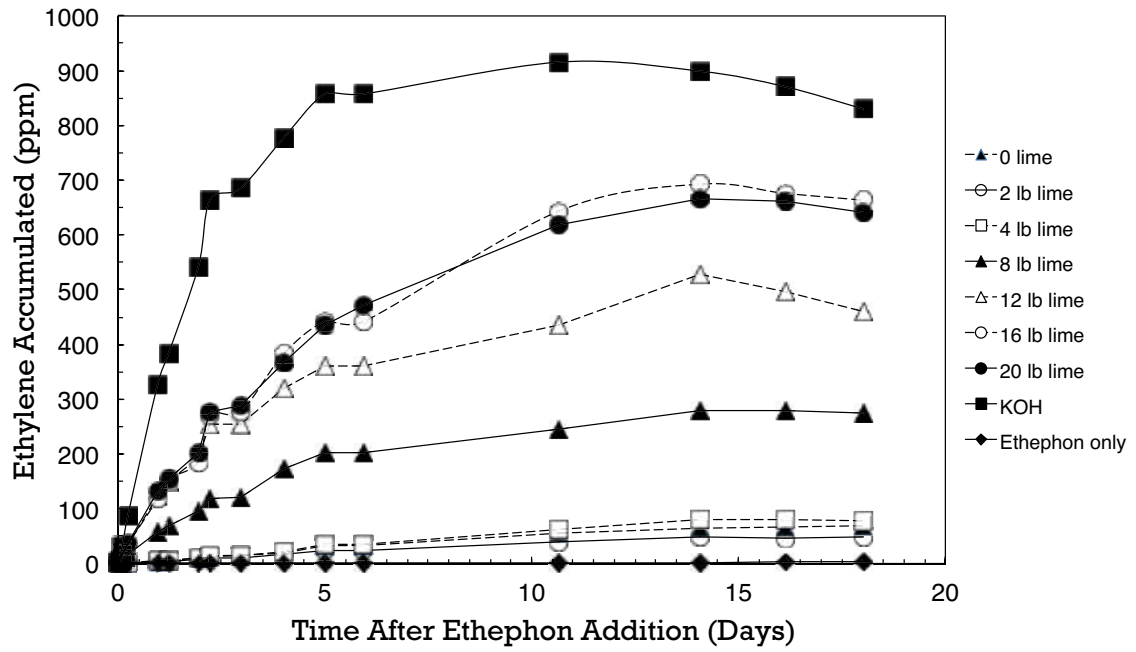
In this first article in a two-part series, we'll look at Florel release as affected by substrate pH, and results of Florel drenches on daffodils and

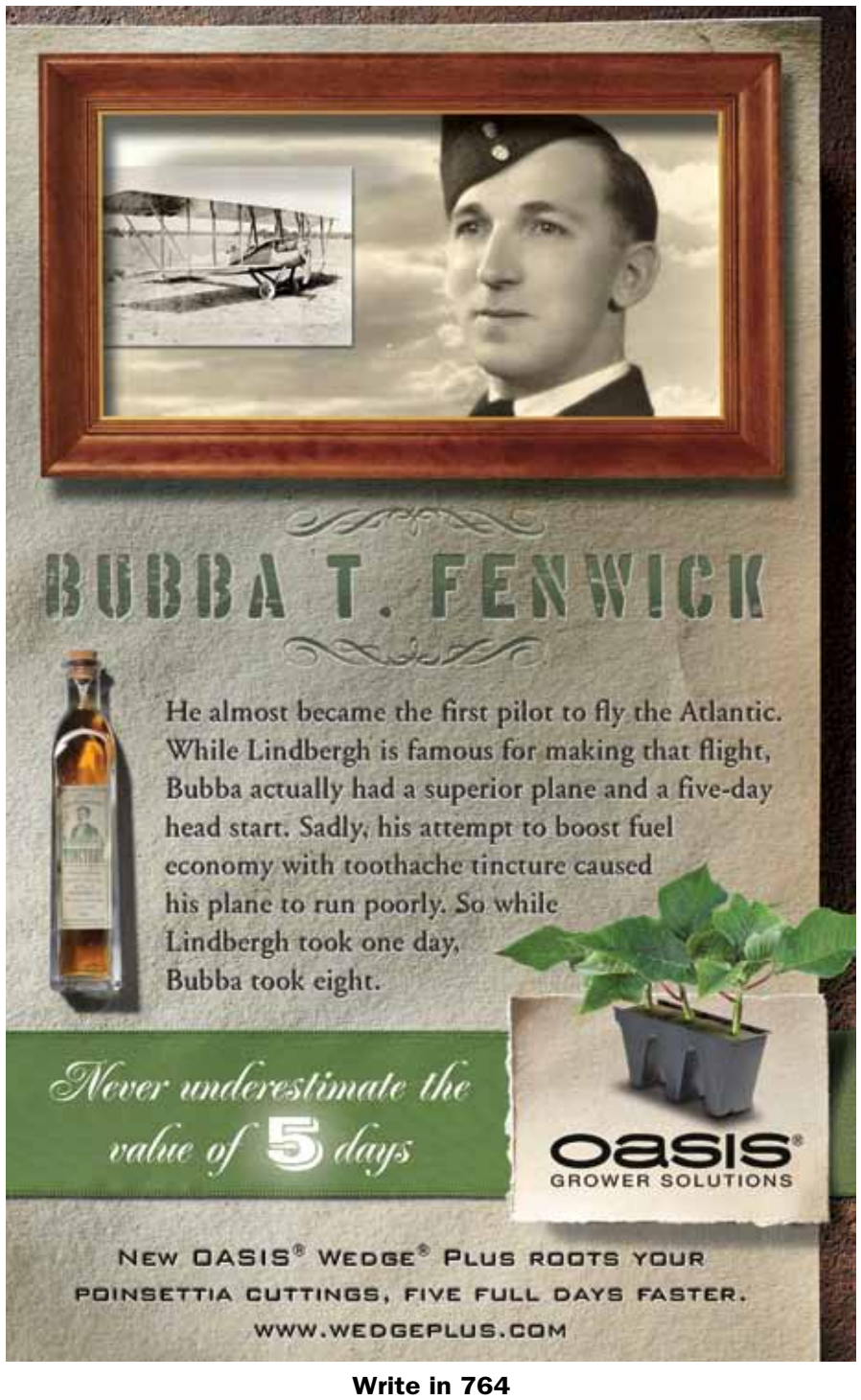
hyacinths. In the second article, effects on a variety of seed and vegetative annuals will be presented.

Ethylene Released from Florel Drenches

To study the effect of substrate pH on ethylene release, we took pure Canadian sphagnum peat moss and incorporated dolomitic lime at rates of 0, 2, 4, 8, 12, 16 and 20 pounds per cubic yard. We moistened the mixes very slightly and held them for three weeks. This resulted in substrates ranging in pH from 3.9 to 7.3 (Table 1). A volume of mix equal to a 4-inch pot was placed in a 1-quart jar and measured amounts of 100-ppm Florel were added. Jars were sealed with lids fitted with rubber septa and held at room temperature for 18 days. At intervals, a sample of the gas from inside each jar was removed with a syringe and injected onto a gas chromatograph to measure the ethylene accumulated. We also had two controls without any peat. One was Florel by

Figure 1. Ethylene release (accumulation over 18 days) from Florel, applied to peat moss amended with varying levels of dolomitic lime.





itself (Florel-only treatment) and the other was Florel by itself with a pellet of potassium hydroxide that was added to instantly raise the pH. This second treatment was to show the maximum amount of Florel that could be released (Florel-KOH treatment).

Results

The results were very interesting. The Florel-only treatment showed no ethylene release over the 18 days, showing that the Florel was stable at a low pH for the duration of the experiment. This also indicated that Florel solutions are stable under industry situations, presuming that the pH is below about 6.0. The Florel-KOH treatment showed maximal ethylene accumulation (that is, full release) within 4-5 days, with ethylene ultimately accumulating to about 900 ppm in the jar.

And, as expected, more ethylene was released, more quickly, as the amount of lime and pH, increased (Figure 1). Due to the need to let the ethylene accumulate for measurement, we had to seal the mix in a jar, so this experiment is artificial compared to a drench to a plant in the greenhouse.

Ethylene is released from the substrate over many days, and the speed of release varies within the pH range of soil-less mixes (5.4 to 6.2). Florel substrate drenches can perhaps be thought of as a "slow release" ethylene treatment system. Substrates at a low pH have a longer but slower release of ethylene than those at a higher pH.

Figure 2. *The effects of a Florel drench on 'Carlton' daffodils at full flower. Eighteen cold weeks in the greenhouse of March 6. Left to right: Control, 100-, 200-, 300-, or 500-ppm Florel drench (4 ounces per 6-inch pot) applied at the 2- to 4-inch leaf stage.*

Effects of Florel Drenches in Daffodils and Hyacinths

Various cultivars were planted in Lambert LM-111 (a commercially available substrate with coarse peat moss, coarse perlite and lime) in 4- or 6-inch pots, irrigated, and placed in a cooler. Temperatures were initially 48° F, decreasing to 34° F as rooting proceeded. Plants were given a total of 17 or 18 weeks of cold. After cooling, plants were forced in the greenhouse at a 63° F night temperature and 63 to 68° F day temperature.

Florel drenches were applied at 0 to 500 ppm at volumes of 2 ounces per 4-inch pot and 4 ounces per 6-inch pot. The time

Figure 3. *The effects of a Florel drench on 'Ice Follies' daffodils at full flower. Eighteen cold weeks, in the greenhouse on March 6. Left to right: Control, 100-, 200-, 300-, or 500-ppm Florel drench (4 ounces per 6-inch pot) applied at the 2- to 4-inch leaf stage.*

Figure 4. *The effects of a Florel drench on 'Primeur' daffodils at full flower. Seventeen cold weeks in the greenhouse on Jan. 31. Left to right: Control (no Florel) or 250 ppm applied (4 ounces per 6-inch pot) one, six or nine days after transferring plants into the greenhouse.*

Figure 5. *The effects of a Florel drench on 'Pink Pearl' hyacinths at full flower. Seventeen cold weeks in the greenhouse on March 8. Left to right: Control, 200-, 350-, or 500-ppm Florel (2 ounces per 4-inch pot) applied three to four days before the first flower opened.*

of application was the same as for a normal Florel spray: when daffodil leaves were about 3 to 4 inches tall, and for hyacinths three to four days before the lowest flower opened. Results are summarized below.

• Florel drenches are a useful method of height control in pot daffodils. Good height control, and especially reduced postharvest growth were seen with Florel drenches. Figures 2 and 3 show 'Carlton' and 'Ice Follies' drenched with 0- to 500-ppm Florel.

• Most daffodil cultivars showed excellent control with a 200-ppm drench (4 ounces of drench per 6-inch pot) with little additional effect as rates increased up to 500 ppm. Cultivars such as 'Carlton', 'Ice Follies', 'Primeur', 'Exception', 'Cotinga', 'Ice King', 'Tahiti', 'Marieke' and 'Westward' performed well with Florel drenches.

• Regarding timing of the drench in the greenhouse, initial experiments suggest a slightly greater effect from drenches made even later than normal Florel sprays. More work needs to be done on this, but it seems clear that there is no benefit from applying Florel drenches very early. See photo of 'Primeur' in Figure 4.

• For most daffodil cultivars there was no difference in flower number or senescence and we have never seen direct phytotoxicity from Florel drenches on bulb crops. There does tend to be a slight delay in flowering (one to four days, varying by cultivar), though this may not be commercially significant.

• 'Tete-a-Tete' is the most popular daffodil cultivar, and is widely used for 4-inch production. In some experiments, we have seen fewer flowers on 'Tete-a-Tete' treated with a Florel drench. As the concentration of Florel in drenches increased, the number of open flowers was reduced. This was mainly seen with very early treatments (two days after transfer to the greenhouse). Applications at four or seven days after transfer to the greenhouse did not reduce 'Tete-a-Tete' flower numbers. Accordingly, Florel drenches should be used with great caution on 'Tete-a-Tete'. It is hoped that more research will reveal a robust system for handling Florel drenches with this important cultivar.

• Two daffodil cultivars, 'Thalia' and 'Geranium', showed flower abortion from Florel drenches, so it is clear that there are cultivar response differences.

• Hyacinths also show a good response to Florel drenches, as seen with the 'Pink Pearl' (Figure 5).

Overall, this work highlights the potential for an entirely new way to approach the use of Florel. Drenches might offer the opportunity for "slow release" ethylene release from Florel, and release rates might be adjusted by substrate pH, and possibly other factors that remain to be studied (for example, temperature, crop type, relative humidity, etc.).

We must clearly note, however, a drench application of Florel is not labeled and so we can not recommend this application method use at this time. The results presented here, especially on daffodils, are very encouraging, and we hope might lead to consideration of drenches as a labeled use for this material in the future. Finally, although not tested, we would expect the new PGR Collate (which also contains ethephon) to elicit similar responses. g

William Miller is professor and Neil Mattson is associate professor in Cornell University's department of horticulture. Roberto Lopez is associate professor, and Christopher Currey and Kasey Clemens are graduate students in Purdue University's department of horticulture and landscape architecture. Michael Olrich is a floriculture research technician and Erik Runkle is associate professor in Michigan State University's department of horticulture. For more information on this article, contact Miller at wbm8@cornell.edu.