



# RESEARCH NEWSLETTER



This Flower Bulb Research Program Newsletter is published by Anthos, Royal Dutch Trade Association for Nurserystock and Flowerbulbs in cooperation with Dr. Bill Miller of Cornell University.

## A Review of Procedures for Forcing High Quality Rooting Room Bulbs

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In this newsletter, we'll review some of the main issues commonly seen and asked about in the fall planting season for rooting room bulbs. In many cases, additional information is available on our web site, [www.flowerbulbs.cornell.edu](http://www.flowerbulbs.cornell.edu), and the reader is referred there for more information. The Holland Bulb Forcer's Guide is also an essential reference and should be consulted as needed.

As always, we at Cornell appreciate and gratefully acknowledge the Dutch flowerbulb industry, though the trade association, Anthos, for their ongoing financial and logistical support.

### Storage of Dry Bulbs on Arrival

Bulbs should be inspected upon arrival. Open crates and visually look at the bulbs. Bulbs such as tulips, hyacinth, daffodil, crocus and iris should be firm, dry and free of excessive mold. If there is an excessive degree of external blue mold, this usually suggests bulbs were too wet in shipment, perhaps from failure of cooling or ventilation equipment. While this may not be the basis for any forcing problems, the bulbs should be aggressively ventilated with fans to promote drying off. Temperature recorders (increasingly, these are electronic devices which must be returned for a read-out) should be promptly accessed and returned, if necessary.

Storage temperature after arrival is also important. Different bulbs have differing optimum storage temperatures depending on their final use (pots, cuts, etc.) and scheduling. *The temperatures suggested by your supplier should be followed!*

Non-precooled tulips, hyacinths, daffodils, crocus, dwarf iris and muscari are usually held ventilated at 63-68F (17-20C) until cooling begins. Again, consult with your supplier.

Perhaps most important is that if the bulbs are precooled, it is essential they be maintained cool, and at the specified temperature, so as to not interrupt accumulation of cold stimulus for flowering.



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### Sanitation of Pots and Equipment

Clean work areas, surfaces, boxes, trays and pots are essential for high quality, hassle-free forcing. Between seasons, black plastic crates used for holding pots, or forcing cuts, should be disinfected with an approved material such as Greenshield or similar product. Disease spores and resting structures can persist in soil/media residue and cause repeat infections in following crops. If nothing else, pressure washing with water to remove most residue is preferable to no treatment at all.



**Used (dirty!) pots or trays carry over soil residues that may contain disease spores. It is best to wash and sanitize before re-use.**

### Soil and Substrate

Spring forced bulbs such as tulips, hyacinths, daffodils, etc. should be planted into pasteurized (essentially, disease-free), well-draining substrates with pH of 5.5-6.5, relatively low in fertility, and cool to the touch. In the past, de Hertogh tested several commercial substrates, and found a wide range to be acceptable to use. As well, we have, in the Flower bulb Research Program, tested a number of substrates and have reached a similar conclusion. In fact the only mix that performed notably poorer than the commercial mixes we used was a homemade, soil-containing mix (our "KPL Mix").

The main characteristics, as mentioned are rapid drainage, freedom from disease, correct pH, low fertility and cool. To this list one should also add cost (it must be economical...but be wary of the cheapest mix available, as it may have quality or consistency problems), weight (while light weight mixes are favored, many bulbs can push up and out of the soil if not planted deeply enough) and air-filled porosity after a full watering. Mixes that are too fine will hold too much water after irrigation with the potential for root rot.

### Soil Temperature

In most cases, bulbs will be put into a 40-48F (5-9C) cooler after planting to begin (or continue, depending on the situation) cooling. Substrates that have been passed through a steam treatment must be allowed to aerate and cool sufficiently before planting. Similarly, substrates in large piles can heat up (due to compost processes), and this should be monitored as well. A safe bet is to not plant into soils unless that are at or below 60F (15C) going into pots, and 55F (13C) is better. There are two main issues here. The first is direct heat injury if mixes are literally too warm (we have seen instances of people planting into freshly streamed, hot soil), and secondly, warm soils that take a long time to cool down after placing in the cooler. This can promote pathogen growth and depending on the situation, can cause cooling and scheduling (flowering) problems.

The above applies to pots or cut flowers in crates where artificial cooling will continue to reduce soil temperatures after planting. If planting is made directly into in-greenhouse ground beds (planting directly into the earth, as with "5-degree tulips"), soil temperature is of even more concern, and should absolutely be below 55F before planting, and 52-53F is better.

### Moisture Content During Planting and Storage

The main issue with substrate moisture is really in storage. Most growers are fully familiar with the need to either have wetting agents mixed into



their substrate if working on a mixing line, or nearly all commercial mixes have wetting agents incorporated. In North America, we initially water our pots to full saturation (based on long standing advice) before putting them into the cooler. This is somewhat different from Holland, where one really does not see spring bulb forcers fully saturating the media at planting time. One idea put forth is that coolers in Holland perhaps are designed differently, with coils and mechanical components that pull less water from the product in the room. In this way, pots dry out less during the long cold period.

In any case, extra water in the pot has a major effect on the degree of root growth during cooling. Plants that are kept wet for the entire cold period will have longer roots and a greater total root mass than pots kept on the dry side. This can have a practical benefit on reducing *Trichoderma* problems during forcing.

On the other hand, it is important to not let pots and trays dry out, so the practice of keeping the floor wet to maintain high humidity is a good one.

#### **How To Avoid Heaving out of the Pot**

A recurring problem that can lead to significant losses is the phenomenon of bulbs lifting themselves out of the soil during initial root growth. This problem is very simply caused by there not being enough weight above the bulb to counter the force exerted by roots growing down into the soil. In Holland, this problem is solved in a rather complex way by shallow planting of the bulbs (mostly, just placing the bulbs on top of the pots of soil), then covering them with a 2-3" thick piece of foam rubber that holds the bulbs down when the next tray is placed on top of them. After 3-4 weeks, when bulbs are well rooted, the stacks are broken down, the foam rubber removed to be used in the later planting, and bulbs returned to the cooler to complete cooling. This leads to bulb products (especially daffodils, hyacinths and muscari) that feature the bulb itself, and significantly enhances the overall product.

In North America, we tend to bury the bulbs so they don't heave up. If there is at least 1.5" (3.5 cm) of mix on top of the bulb, heaving usually does not occur. Again, the issue is sufficient weight of mix on top of the bulb. It seems likely that other treatments that would reduce the initial vigorous root growth of (especially) hyacinths (for example, reducing temperature by a few degrees weeks 2-3 after planting) might help to slow initial root extension and reduce lifting, but we have not tested this idea.



**Hyacinth bulbs lifted out of the pot due to strong and rapid rooting.**



**Tulip bulbs lifting out of the pot due to strong and rapid rooting.**

### Temperature Control In The Cooler

Temperatures in the cooler are critical for several reasons. Most important is that each cultivar has a minimum and optimum duration of cooling for its intended use. Bulbs that do not receive enough cold will flower too late or not at all, and are likely to have various flowering abnormalities (green or bleached flower or petal tips, too short stems, etc).

Cut tulips tend to be cooled at lower temperatures than pot tulips because cooling at lower temperatures (e.g., 35-38F vs. 45-48F) will produce tulips with longer stems and shorter flowers. Thus, for pot tulips, cooling on the warmer end is, in theory, beneficial to producing a slightly shorter plant with larger flowers.

The problem comes with root and shoot growth. As pointed out above, excessive early root growth leads to heaving problems in hyacinth and daffodils, and increases susceptibility to *Trichoderma*. Cooling the crop at a lower than typical temperature can dramatically reduce total root mass in tulips, and can help with *Trichoderma*. The typical schedules and recommendations for pot tulips are to start cooling at 48F (9C), reduce to 40F (4-5C) when bulbs are well rooted, and the lower temperature to 33-34F (1C) when shoot growth reaches 1". While these are excellent general guidelines, if you feel your crop is putting on too many roots, you should reduce temperature quickly, as the lower temperature will reduce root growth. This is also compatible with reducing shoot growth, as one of the biggest problems is when shoots grow up into crates stacked above, leading to a near total loss of quality.

### Optimum Cooling Time

Every cultivar has a minimum, optimum and maximum cooling duration that depends on its final use. In general, tulips grown for cut flowers have a longer optimum cooling duration than if the same cultivar is used in pots. As a general rule, spring bulbs flower faster, more uniformly and taller as cooling duration increases. Specific information on cooling duration should be

available foremost from your supplier, and you should have close consultation as far as scheduling crops and cultivars for each intended forcing period. A large volume of information is on the website of the Flower Bulb Research Program website ([www.flowerbulbs.cornell.edu](http://www.flowerbulbs.cornell.edu)), and more is on the way.

Diagnosis of cooling problems changes throughout the season. Obviously, early season forcing, where plants are being pushed to flower as early as possible, is when you see evidence of lack of cooling, and symptoms may vary from green tips of hyacinth flowers, to white/tan tips of tulip petals, to excessively short stems that flower inside the leaves (tulips). Such problems can also occur with later forcing, but are less common. In late season forcing, one can begin to see problems from too much cooling (rapid, weak and too tall growth, lack of stem and leaf strength, small flowers).

What is "too much" cooling? In North America, we tend to plant bulbs in a rather narrow window in the fall, and put it all into the cooler. Crops for mid-season forcing (e.g. an early Easter) might receive perfect cooling, whereas late Easters and certainly Mother's Day forcings are usually over cooled. While PGR use can increasingly help with excessive growth from over cooling (see below), the rapid plant development can cause challenges all throughout the marketing chain.

### Greenhouse Temperatures

A commonly used greenhouse temperature for mid-season forcing is 63F (17C) day and night. Most crops can tolerate significant deviation from this. Early crops are usually grown somewhat warmer to speed development for the earliest market, whereas lower temperatures can reduce growth rate and delay flowers (this is not always possible with late crops, however).

Five degree tulips, which are given all cold before planting, must be grown significant cooler (50-55F constant) as a way of reducing shoot growth be-



fore a root system is developed. See above under “soil temperature” for more information on planting 5-degree tulips.

### Use of Plant Growth Regulators (PGRs)

The Flower Bulb Research Program has generated a large amount of information on currently used and available PGRs and much of it is available online at [www.flowerbulbs.cornell.edu](http://www.flowerbulbs.cornell.edu) PGR use in bulb crops is somewhat different than in the rest of floriculture in that in many cases our products continue active height growth after forcing has ended, so growth is active during shipping, retailing and for the consumer. Therefore the main need for PGRs in spring bulb crops is for *postharvest growth control (that is...growth control to benefit the consumer)*, as compared to growth control to reduce height in the greenhouse for the grower.

In the last few years, Topflor (fluprimidol) has emerged as the product for height control in the main assortment of spring bulbs. Excellent results can be obtained with pre-plant dips (hyacinths, daffodils, and tulips) or with soil drenches (hyacinths and tulips). Topflor treatments are available that can very effectively reduce postharvest stem stretch, and should allow improved quality in the postharvest retail and consumer chain.

For more specific PGR information on spring bulbs, you may consult past newsletters online at [www.flowerbulbs.cornell.edu](http://www.flowerbulbs.cornell.edu) Also, information (by cultivar) for hyacinth pre-plant dips and tulip (in-greenhouse drenches) is available there as well.

### Postharvest of Finished Products

Perhaps the largest single issue for spring bulbs is their relatively short postharvest life span. Imagine if we had a bulb that forced like a tulip and lasted like a Phalenopsis! Since we are limited by the crops themselves, it is critical to maximize lifespan for the consumer. By far, the two

most important factors in maximizing postharvest life are 1) proper harvest *stage* and 2) cold storage, shipping and handling temperatures.

If harvested and marketed too late, display life is lost for the consumer (that is, it happens on the bench or store, and not with the consumer). Harvest stage varies from sprouted plants (as in the case of spring bulb bedding plants) to half colored buds (for local cut tulips), or pencil stage in daffodils.

As far as temperature, all rooting room bulbs are best held at 33-35F (0.5 to 2C), or as near to 32C as possible, (without freezing). While many can tolerate some degree of cold storage after forcing, storage of the shortest duration as possible would always be recommended.

Most spring bulbs are relatively insensitive to ethylene especially at low temperatures. One exception is hyacinth, which if exposed to ethylene at room temperatures, shows premature flower wilt and discoloration on the bottom of the flower (see nearby photo).

### Trichoderma in tulips



**Symptoms of ethylene injury on hyacinth. Plants at half-flower were exposed to 1 ppm ethylene overnight at room temperature.**

Each year there are outbreaks of *Trichoderma* (*T. viride*) in tulips. This problem shows at the very end of forcing, when the leaf tips turn gray or light brown, more or less as buds start to color. *Trichoderma* is suspected to be a ubiquitous organism (that is, it is found everywhere in horticulture), but is probably most often introduced into the tulip forcing system through the peat moss used in the growing mix. Problems mainly occur with heavily rooted plants so the main control strategy has been to adopt practices to reduce root growth. The most common one recommended is to add about 25% river sand to the mix. This reduces water holding capacity, and thereby reduced root growth.

In the greenhouse, never let the plants dry out (the circling roots on the bottom of the pot are very susceptible to stress!), and avoid forcing with bottom heat. Studies in Holland showed that plants grown on a solid surface where roots could grow out of the pot and continue growth between the bottom of the pot and the bench surface were especially susceptible to infection. If necessary, place crates on 1-2" diameter pipes (or other crates) to elevate crates above the floor. The idea being to allow quick and decisive "root pruning" of roots as they exit the pot or crate. Similar precautions should be taken if growing on substantially closed benches.

Our fact sheet on *Trichoderma* in tulips can be found in the newsletters section of the Flower Bulb Research Program website at <http://www.flowerbulbs.cornell.edu/newsletter/Trichoderma%20May%202004.pdf>



Early leaf-tip symptoms of *Trichoderma* on 'Leen van der Mark' tulips.



*Trichoderma* symptoms in 'Gavota'



Roots of a *Trichoderma*-infected tulip plant. Note the matted edge of roots that has no attached soil. The roots are "glassy" and slippery. Note also the white fungal mycelium on the roots.