

**Editor's Note:** The following two articles are examples of the excellent educational sessions that were held at the 2004 OFA Short Course. Don't miss your opportunity to attend similar sessions and get other vital industry information at this year's OFA Short Course on July 9-12. Visit [www.ofa.org](http://www.ofa.org) to review the program and all session descriptions.

## Update on Bulb Crops



by William B. Miller, Ph.D.

Successful production of bulb crops involves detail and manipulation of the product before and during forcing. However, the details for producing bulb crops are no more involved than those for poinsettias or chrysanthemums. Readers are referred to the *Holland Bulb Forcer's Guide* (authored by A.A. De Hertogh) for details to supplement this overview. A major advantage of spring bulbs such as tulip, daffodil, crocus, hyacinth, etc. is the short-to-very short greenhouse time and the close spacing, usually pot-to-pot. This potentially allows many turns of the greenhouse space and consequently high returns per square foot.

### Rooting Room Bulbs – Tulip, Daffodil, Hyacinth, Crocus, Dwarf Iris, etc.

One of the most critical steps for successful forcing of these bulbs is giving the proper length of cold treatment. Depending on the cultivar, product type, and the forcing period, the length of cold treatment may range from 10 weeks in the case of prepared hyacinths for early forcing to more than 20 weeks for late-forced daffodil or tulip crops. With many bulbs, it is possible to give some of the cold to

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unplanted bulbs ("precooling"). Precooling is done for early forcing, and it is most often done by your bulb supplier.

Upon receipt of precooled bulbs, it is critical that they are inspected for quality attributes (presence of disease or mechanical injury from shipment), then planted as soon as possible. After planting, pots typically are placed into a rooting room at an initial temperature of 48°F (9°C). Since the bulbs are already partly cooled, root growth tends to occur quickly, and pots will be well rooted within three or four weeks. Then temperatures must be reduced to retard shoot growth.

Bulbs for later forcing are not precooled, so the forcer (usually) gives the entire cold period to the bulbs after they are planted. Thus, nonprecooled bulbs are inspected upon arrival, planted, then placed into the rooting room.

The long-standing planting and cooling guidelines for spring bulbs are as follows:

- Water in bulbs after planting. Keep high humidity in the rooting room. Usually, keeping the floor wet is sufficient to keep the pots moist.
- Initially maintain 48°F (9°C) for rooting. As pots become well-rooted (roots coming out of the holes in the pot), lower temperature to 41°F (4°C). Cultivars vary in rooting speed, so approximations are necessary. Watch temperatures closely.
- Maintain 41°F (4°C) until shoots are 1 inch long, and then reduce

temperature to 32 to 35°F (0 to 2°C) to minimize shoot elongation. Again, species and cultivars vary, so approximations are necessary. Precooled crops will go into rooting room A, while crops for later flowering will be in rooting room B.

- d) *Theoretical* schedules for rooting rooms:

<u>Rooting Room A</u>	<u>Rooting Room B</u>
48°F to Nov. 5-10	48°F to Dec. 1-5
41°F to Jan. 1-5	41°F to Jan. 1-5
32 to 35°F	32 to 35°F
till greenhouse	till greenhouse

Note that I say "theoretical" with these schedules. In recent years, the thinking has been shifting toward getting the planted bulbs colder and faster. For example, you will now commonly hear recommendations to plant, get them rooted at 45 to 48°F, then drop the temperature rapidly (within a couple of days) to 34 to 35°F. The idea here is to reduce excessive root growth, which can contribute to *Trichoderma* and other disease problems in tulips.

- Give the proper number of cold weeks for each cultivar. All temperatures, from 48°F to 32°F (9 to 0°C) are "cooling" temperatures. Total length of cold is all time spent in the rooting room plus any precooling time, if any, given by your supplier. A general rule for tulips is: the lower the cooling temperature, the longer the stem, but smaller the flower. Consult the *Forcer's Guide* for

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detailed information. Be certain to keep shoots short in the cooler, typically less than 4 inches. Once well rooted, it's better to reduce temperature early to minimize shoot growth, especially given this year's (2004) late Easter.

- f) When needed, use the proper growth regulator at the right time for height control. This is usually within just a few days after moving to the greenhouse.

### Growth Regulators on Spring Bulbs

Depending on the growing situation, tulips, daffodils, and hyacinths can all benefit from growth regulator application. Growth regulator use on spring bulb crops is somewhat complicated by variety of chemicals, application methods, and rates involved. The basic techniques are given below. Much more detailed information can be found in the *Holland Bulb Forcer's Guide*. Tulips are most commonly treated with A-Rest or, increasingly, paclobutrazole (Bonzi or Piccolo) drenches. Since the paclobutrazol must be applied before the plant is more than 4 to 5 inches (10 to 12 cm) tall, drenching is done within just a few days of bringing pots into the greenhouse. Paclobutrazol drenches are typically in the 0.5-2 mg/pot range (this is 4.1 to 16.6 ppm paclobutrazol, assuming 120 ml are used on a 6-inch pot).

Daffodils (including paperwhites) and hyacinths benefit from Florel (ethephon) sprays for height control. Rates are typically 500 to 2,000 ppm, depending on the cultivar and forcing period. Multiple applications may be needed. Again, early treatment is necessary, optimally before plants are 4 inches tall. Hyacinths must be treated before florets are open and substantially colored, otherwise flower blasting and greatly reduced postharvest life will result.

### Common and Current Disease Problems

The last few years have seen an increase in *Fusarium* infection in Dutch tulip bulbs. There are many

speculated causes for this, and I think no one knows the full story. Different production locations, systems, machinery, cultivars, weather, and size of farm all seem to be contributing to the problem. *Fusarium*-infected bulbs have light tan and brown blotches, usually on the base of the bulb. Aside from rendering the infected bulb useless, *Fusarium* infection and produces huge quantities of ethylene, and this ethylene can cause problems (poor rooting, uneven growth, flower blasting) in other tulip bulbs. This is a problem mainly before cooling starts, although it is also known that infected bulbs continue producing ethylene when plants are moved into the greenhouse after cooling. This ethylene can diffuse through the media, and cause growth problems in other plants in the pot. As far as forcers are concerned, the main control is to carefully inspect each bulb, and throw out infected bulbs prior to planting. Also, buy from high-quality, reputable suppliers. *Fusarium* has been a major problem for the industry; but in general, Dutch suppliers have done a very good job trying to get this problem under control.

Another disease that keeps popping up is *Trichoderma*. This disease probably infects most all tulip cultivars, but only certain ones show visual symptoms, which are grayish leaf tips developing in the last few days in the greenhouse. The fungus probably originates in the planting mix, as *Trichoderma* is a ubiquitous organism. The fungus is only a weak pathogen on tulips, so a weakened plant is key for infection and symptom development. The usual case is when tulips become heavily rooted in the cooler; and these heavily matted and circling roots are stressed, for example, by drying out, or perhaps salt stress. The pathogen can then invade and cause the injury. Prevention is mainly by sanitation, avoiding all plant stress (do not allow plants to dry out) and handling pots or crates so roots coming out of the bottom are "air-pruned," so the roots do not grow below the pot.

### Muscari, Dwarf Iris, Crocus, Scilla

These bulbs are easy to grow, but do require attention to detail. These are rooting room bulbs, and generally

require cold periods ranging from 14 to 17 weeks. Crocus, dwarf iris, and squills are best sold directly from the rooting room as sprouts. They green up quickly, but also flower quickly, so a greenhouse period really is not necessary. In all cases with this group, prompt marketing is important, as the overall shelf life of these crops can be low. Warm temperature is the main accelerator of quality loss in the retail chain and consumer environment.

Grape hyacinths are a slightly different story, because a high-light greenhouse period of three to four weeks at 55 to 60°F/12 to 16°C NT is required. A problem with grape hyacinths can be excessive leaf growth, leading to an unkempt-looking plant. This is due to normal rooting after planting and placing in the rooting room. The roots absorb water, thereby driving leaf growth. There are two simple solutions to this: 1) reduce temperature in the rooting room to 32 to 33°F (0 to 1°C) as soon as plants are rooted, or 2) a better approach is to "precool" the bulbs dry for about three-quarters of the required cooling time, then plant and immediately return to a 40 to 48°F/4 to 9°C cooler for the last three or four weeks of cold. Later planting (but with the same total cold weeks) simply delays rooting and the excessive leaf growth associated with it.

### Marketing and Postharvest Opportunities with Spring Bulbs

A recurring opportunity I see is low quality at the retail outlet. I commonly see spring bulbs suffering in quality in the retail chain, and not just in high-volume chain stores. While the fault may indeed lie with the store for failing to remove these bad products from the shelves, growers must also pay careful attention to shipping bulb crops at the appropriate time – and thus the opportunity to increase your product's value to the retailer. From a purely business view, the "optimum stage" to ship a product is when and how the customer wants it! From the plant's viewpoint, it must be developed sufficiently to tolerate the "harsh" conditions of the retail/consumer environment, but not so far along that longevity for the consumer is lost in the greenhouse itself.

Thus, the optimum shipping time for tulips, hyacinths, and daffodils is well before flowers open. Optimum shipping stages are as follows: tulips – “green bud” stage; hyacinths – before florets open; daffodils – when buds are “green pencils.” Crocus and dwarf iris are shipped as sprouts, essentially just out of the cooler. In Europe, hyacinths are sold as rooted bulbs so the consumer can watch leaf and flower development, and get several weeks of enjoyment from the product. Perhaps this concept is exploitable in North America, too.

Selling sprouted bulbs should not be limited to pots for indoor use. As bedding or garden plants, bulbs have great potential, too! Selling rooted and sprouted spring bulbs can be a great way to get early-season sales for customers who just didn't get those bulbs planted in the fall. Think also about larger pot sizes, perhaps 15 to 20 tulips in a 12-inch pot. These are non-commodity items, and you should be able to command a premium price for these kinds of product.

### Non-Rooting Room Bulb Crops

#### *Oxalis*

*Oxalis* or Everblooming Shamrock Plant is a special bulb crop widely grown for the St. Patrick's holiday in 4-inch pots. Its usage could be expanded to year-round programs, as rhizomes are available throughout the year. By far, the most commonly grown are *Oxalis regnelli* and *Oxalis triangularis*. *Oxalis regnelli* has three deeply cut, green leaflets, with a five-petaled white flower. *Oxalis triangularis* is often (and mistakenly) called ‘Pink regnelli,’ but it differs in having deeply cut, purplish three-leaflet leaves with five-petaled pink flowers. It is also more tolerant of higher temperatures than *O. regnelli*, has fewer flowers per rhizome, and is about 20 percent to 30 percent slower to flower (one- to two-week delay) than *O. regnelli*.

• **Growing.** The key steps are: grow warm, grow on the dry side, and

don't overfertilize. Plant rhizomes immediately upon arrival, or store them at 40 to 50°F if necessary for only a few days. Plant three rhizomes per 4-inch pot, or four per 5-inch or 6-inch pot using a well-drained greenhouse mix. Plant 0.5 to 1 inch deep, and water in. The crop gets off to the best start if grown with 70 to 75°F soil temperature until well established, then drop to 65°F nights. Lower temperatures will severely delay the crop and should be avoided during establishment. Cool temps can be used, however, to hold crops near finish. The crop is grown pot-to-pot in a medium- to high-light greenhouse. Spacing may be necessary depending on light level, temperature, and age of the plant at market. PGR sprays or pre-plant dips are useful for maintaining compact plants in the greenhouse.

• **Watering and Fertilizing.** After the initial watering, allow the soil to dry somewhat to help minimize pathogen infection and encourage root growth. After establishment, grow the crop on the dry side to minimize rank vegetative growth. A weekly application of 200 ppm N is usually sufficient. Don't fertilize until the plant is well established with a good root system.

• **Problems.** *Oxalis* can get an inter-veinal chlorosis that is especially pronounced at lower growing temperatures. Although the exact cause is unknown, dilute micronutrient sprays have been effective if the problem develops. Wrinkled leaves and leaf edge burn also happen fairly frequently; again, the cause is currently unknown, but salts or high light may be suspect. Spider mites are the major insect pest; Avid and Pentac are effective for control.

#### *Amaryllis*

The “amaryllis” we commonly grow is actually *Hippeastrum* sp. and is native to South America. This non-rooting room bulb is produced in Holland, Israel, South Africa, and increasingly in other countries such as Brazil. Southern hemisphere-produced

bulbs have an advantage as far as earliness to flower. There is an ever-increasing cultivar assortment.

• **Growing.** Bulbs should be planted upon arrival. Unless otherwise discussed with your bulb supplier, all temperature manipulations should have been completed prior to shipment. Plant with one-third of the bulb above the soil level, place pot-to-pot on the bench, and water in well with clear water. Avoid getting water in the “nose” of the bulb to avoid disease. A variety of temperatures can be used for forcing. Warm temps (70°F nights) speed rooting overall growth, but temps as low as 60°F are fine as well.

• **Marketing.** While a single bulb in a 6-inch pot is most common, consider using multiple bulbs in larger containers, perhaps three or five bulbs in a 10- to 12-inch pot. Because of high shipping costs, these large items can be a great niche for local grower-retailers. Such pots make an impressive display, and they can command a high price as a non-commodity item. Market when the flower stem is 12 inches tall, preferably with six 12-inch leaves.

#### *Scilla peruviana*

This is a new crop with an exotic and tropical appearance. One advantage of this crop is the cool growing temperature, but relatively long crop times are required. It is best to grow this product in a cool greenhouse (50 to 55°F/10 to 13°C), and bench times of 9 to 11 weeks are necessary for flowering.

#### Hybrid lilies

Hybrid lilies are increasing popular crops – as flowering pots, as growing perennials for late spring/early summer sales, or as nearly finished patio or deck plants in larger containers. There are a variety of cultivars in the Asiatic, oriental, and LA-hybrid groups, with all colors represented. Cornell's research work has led to a good understanding of the height control techniques

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needed, and this usually starts with a one-minute preplant bulb dip in Bonzi or Sumagic. Rates are from 50 to 400 ppm Bonzi and 2 to 10 ppm Sumagic, which vary critically by cultivar. Crop times are 8 to 14 weeks in the spring and less as the summer proceeds. While the “pixie” series has been a mainstay in pot lilies, there is a lot more available in this category.

### Other Opportunities

Although this talk has been based on greenhouse forcing, don't forget other uses of flower bulbs to extend sales windows, both in the spring and

into the summer and fall. It is quite possible to grow and market a large number of “spring bulbs” as perennials – the idea being to sell them green in the early spring. In this case, bulbs are planted in the fall with appropriate numbers in a gallon (or larger, as appropriate) nursery container and overwintered under microfoam, Remay, or in white poly tunnels, as appropriate for your location. The cooling occurs naturally in the winter and gives the opportunity for customers to get color early in their gardens. A related idea is the “bulbs as bedding” approach, where

tulips, daffs, hyacinths, etc. are planted in cell packs, cooled, and sold as sprouted plants for immediate spring planting in the garden (for those customers who can't seem to get it together in the fall).

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# The Thrips Connection: Managing INSV and TSWV

## *Impatiens Necrotic Spot and Tomato Spotted Wilt Tospoviruses*



*by Margery Daughtrey, Ph.D.*

### Biology of the Viruses and How They Interact with Thrips

Viruses are very small “pseudo-organisms” that occur as submicroscopic particles containing genetic material (either RNA or DNA) packaged within a protein coat. The virus protein is what is targeted when you use an ELISA test to check for the presence of a specific virus in a plant. An electron microscope is needed to visualize virus particles. These particles come in various sizes and shapes such as polyhedrons, filaments, and rods. Viruses are named according to one of the symptoms that they cause on just one of their host plants, e.g. “impatiens necrotic spot virus,” which

causes more than just necrotic spots on impatiens and produces a wide range of symptoms on many other hosts as well.

The viruses INSV and TSWV belong to a group called tospoviruses that have a membrane surrounding their protein coat. These viruses' genetic material is made up of RNA. They have a very simple life cycle: the viruses make more virus particles by commandeering the resources of the plant host for their own selfish purposes. INSV and TSWV use the Western flower thrips as their transportation service: larval thrips acquire the virus as they feed on infected plant cells; and then after these same larvae become adults, the virus is introduced to new plants as the winged thrips flies about and feeds.

Virus-infected plants are especially attractive to thrips. This means that you can look for plants that have been heavily fed upon by thrips when you are deciding which ones to test for a tospovirus. INSV and TSWV both have a tremendous host range, including most of the herbaceous plants that you grow. Even some sedges are susceptible

to INSV. If the thrips population has been high in the greenhouse, and any crop is looking peculiar, you should consider that it may have INSV.

In our collective experience, INSV is primarily a disease of greenhouse-grown plants, whereas TSWV is more likely to appear as a problem on herbaceous perennials grown in a nursery setting (where there is more contact with outdoor plants). Perennials may of course also become diseased with INSV during greenhouse propagation.

INSV/TSWV and thrips may enter your operation either separately or simultaneously. Be alert to the possibility that the virus may be introduced to your greenhouse at any time on plugs or plants previously grown in another greenhouse, and that the virus may be retained in your own greenhouse in leftover crops or in weeds under the bench. An in-house thrips population may spread the virus and create an epidemic problem after you introduce even a single virus-infected plant. Beware of harboring either thrips or virus in your greenhouse.