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.

Research Newsletter no. 33

October 2014

Preparing for The 2015 Tulip Forcing Season
By Bill Miller

The 2014 field season in Holland was challenging, with warm temperatures early in the growing season, and again after flowering. Warm soil temperatures during the time of bulb development (after flowering) tend to increase *Fusarium* infection in tulips, and this is unfortunately the case this year. Forcers in the US and Canada should be on the lookout for infected bulbs, and ruthlessly remove them prior to planting. Depending on the cultivar, time of the season, etc. even a few infected bulbs in a crate can cause economic loss as outlined below.

A short review on *Fusarium* and tulips is in order. *Fusarium oxysporum* is the fungus involved in basal rot (Fig. 1). The infection process in the field is complicated, and beyond the scope of this article. Suffice it to say with the proper combination of environment, pathogen and host, infections start in the field. Warm soil temperatures increase the likelihood of infection. After the bulbs are harvested, the mechanical processing machinery used in the industry almost certainly cause small injuries to the bulbs and help to spread infections. Cultivars vary widely in their susceptibility to *Fusarium* infection, and these differences are well appreciated in the industry. So, direct infection of individual bulbs by the fungus (basal rot) is one problem caused by Fusarium.

A second, and probably more important problem, is that the *Fusarium* fungus produces ethylene while infecting tulip bulbs. This ethylene can diffuse through a crate or bulk box of bulbs in the storage room and can injure other, non-infected bulbs. (This is why ventilation of bulbs is important…it helps to remove ethylene from the atmosphere immediately around the bulbs). Problems resulting from ethylene are direct flower bud death, severe distortion and abnormalities in flower development, reduced or no rooting. If certain mites are present, kernrot (Fig. 2), where the ethylene from the *Fusarium* causes uneven floral development, causing the top of the "bud" to open, allowing

Flower Bulb Research Program

Dept. of Horticulture Cornell University
134 Plant Science Building
Ithaca, NY 14853, USA
Phone: + 1 0016072272780
Fax: + 1 0016072559998
wbm8@cornell.edu

Anthos
Royal Dutch Trade Association for Flowerbulbs and Nursery Stock

Weeresteinstraat 10
P.O Box 170
2180 AD Hillegom
Phone: +31 252 53 50 80
Fax: +31 252 53 50 88
secretariaat@anthos.org
www.anthos.org

Fig. 1. Typical symptoms of *Fusarium* (basal rot) on tulip. Image 2576.

Fig. 2. Kernrot. Top: Plant in the center shows the light green, "greasy or waxy" appearance that is common with plants with kernrot. Stems on the bottom photo have had leaves peeled off, showing the blackend stumps of remaining floral tissue after mite feeding activity. Images 0987 and 0975.

mites to enter and eat the microscopic flower. This happens throughout the storage phase, and the result is plants with characteristic blackened stumps (remnants of the floral primordial) and blind, "greasy" or waxy plants with a lighter green color in the greenhouse. While an important cause of loss, it is an impressive disorder involving plants, hormones, diseases and mites.

It is extremely important to understand that planting a *Fusarium*-infected bulb will cause losses much greater than the bulb itself. In a pot, with 6 or more bulbs, the infected bulb will produce ethylene during greenhouse forcing, and this ethylene (mostly in the soil environment) will *severely* reduce growth of other bulbs within the same pot or crate (Fig. 3). Thus, the infected bulb has obviously a lost flower, and its presence will usually cause 2 or more stems in the pot to either be blind or at least severely stunted. Perhaps the pot can be plugged with a healthy plant, but this is highly labor intensive and certainly not a desirable operation.

Fig. 3. Effect of a *Fusarium*-infected tulip bulb (center) on growth of tulip plants surrounding it. Note the plants closest to the bulb are smaller and stunted. This is due to ethylene produced by the *Fusarium* diffusing in the soil and casing severely reduced growth and, likely, flower abortion. Image 0915.

Another point is to monitor the substrate temperature at the time of planting. At the time of planting, soil (substrate) temperatures should be 48-50F (9-10C) or below. Think about it…if you plant into warm soils, the bulbs in the pots will be at a warm, moist temperature for at least several days after planting. Such conditions are ideal for disease infections to start (*Fusarium* and others). Most coolers cannot rapidly reduce temperatures in the large mass and volume of bulbs and substrate after planting.

It is known that cultivars vary in sensitivity to *Fusarium* during field production. And, Cornell research has led to a better understanding of the variation in cultivar sensitivity to ethylene (some are essentially unaffected by long, high doses of ethylene after arrival in the US, while others are extremely sensitive). Finally, some cultivars support high levels of ethylene production upon *Fusarium* infection whereas others do not.

The bottom line is to inspect your bulbs carefully and to discard any that show any signs of infection. Also, the long-standing advice of ventilation (blowing fans on stacks of bulbs) helps to force-ventilate away the ethylene.

In the Meantime…Clean up now to Avoid Trichoderma and Other Problems

Regardless of crop status, you must still be preparing for the crop and getting ready for planting and cooling operations.

It is important to start clean! A thorough cleaning of all bulb handling, planting and cooling facilities will help to avoid problems in forcing, especially with diseases such as *Trichoderma* (Figs. 4 and 5). We have a fact sheet on *Trichoderma* on the website, which can be found at http://www.flowerbulbs.cornell.edu/newsletter/Trichoderma%20May%202004.pdf (or, more easily, go to the website at flowerbulbs.cornell.edu and type in "trichoderma" in the search box, and you'll go right to it). This disease is promoted by very heavily rooted plants, as in Fig. 6). When tulips are thickly rooted in pots, the lack of soil among the roots makes the roots more susceptible to drying out, salt accumulation or any number of other stresses,

Fig. 4. Typical *Trichoderma* symptoms. Image 2025.

Fig. 5. 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. Image 5377.

and weakened roots are thought to be more susceptible to the *Trichoderma* pathogen. *Trichderma* is a disease that only shows symptoms in the greenhouse. Symptoms do not show in the cooler because the roots are not damaged (as a result of drying out, high temperatures, etc.) yet. *Trichoderma control is primarily a matter of reducing tulip root mass in the crate or pot.*

Fig. 6. A very heavily-rooted pot tulip. The very heavy mass of roots, circling on the bottom of the pot without any soil adhering, is one of the suggested causes of *Trichoderma* infection. Image 2851.

Use a labeled sanitizing product to clean all areas you will handle the bulbs. Thorough cleaning of planting surfaces, crates, carts, shelves and greenhouse benches can reduce inoculum sources and help to maintain crop health. Contrary to popular belief, crates that are stored outside over the summer and exposed to all the rain, sun and heat are *not* clean and must also be specifically cleaned and sanitized before use. Pathogens can remain on the crates, and roots growing out from the bottom of the pots can pick these diseases up and cause losses during forcing. Most growers use quaternary ammonium or hydrogen peroxide-based products for this. This is the *first* step!

Next, consider the substrate. If growing cut flowers, configure your planting line to drop a 1/2" layer of coarse sand on the bottom of the forcing tray before planting. While the exact reason this is helpful is unknown, it may involve maintaining some contact of substrate and the root mass on the bottom of the crate. For both pots and cuts, a common recommendation is to blend in 20% of coarse, salt-free sand to the mix. The idea here is to reduce the total water content in the container, which will ultimately reduce root growth in the cooler somewhat.

Experience in Holland suggests that growing plants on closed surfaces, or in contact with concrete floors increases the *Trichoderma* problem. Any situation that allows roots to maintain growth outside of the pot of crate is suspected to increase the potential for *Trichoderma.* So, in the greenhouse, growing on open bottom (expanded metal) benches allows rapid air pruning of the roots and helps reduce *Trichoderma*. Cut flower growers have had success by placing the crates on ca. 2" diameter pipes or 2-3" tall bricks (Fig. 7). The airflow beneath the crates allows root pruning and reduces *Trichoderma* problems.

Fig. 7. Cut tulip crates grown on bricks to aid in rapid air pruning of the roots to help reduce *Trichoderma.* Image 7280.

Another, perhaps easier, way to reduce excessive root growth is to reduce the temperature in the cooler earlier and more extensively than usual. For tulips, hyacinths and daffodils, root growth is closely related to temperature. In typical rooting rooms, temperatures are reduced gradually over a 4-5 week period from 9C to 1C (48 to 34F) as the roots develop. In recent years, more growers have been reducing rooting room temperature more rapidly than before, and one result is less heavily rooted tulip plants. Our research at Cornell confirms this. We planted tulip, daffodil and hyacinth bulbs and placed them at temperatures from 33 to 49F (1 to 10C).

After 6 weeks, the difference in root growth was really impressive (Figs. 8-9-10). Certainly colder temperatures have a large effect in reducing root mass. There are other side effects, however, as tulips cooled at a colder temperature will theoretically be slightly taller and may have slightly smaller
flowers.

Fig. 8. Effect of rooting temperature on root growth of 'Leen vd Mark' tulips. Bulbs were planted, watered, then cooled for 6 weeks at (L to R) 1, 4, 7, or 10C (34, 40, 45, 50F). Image 7608.

Fig. 9. Effect of rooting temperature on root growth of 'Tete-a-Tete' daffodil. Bulbs were planted, watered, then cooled for 6 weeks at (L to R) 1, 4, 7, or 10C (34, 40, 45, 50F). Image 7607.

Fig. 10. Effect of rooting temperature on root growth of 'Pink Pearl' hyacinths. Bulbs were planted, watered, then cooled for 6 weeks at (L to R) 1, 4, 7, or 10C (34, 40, 45, 50F). Image 7610.

This may or may not be noticeable in the final crop, however. Another side effect of colder coolers is that hyacinths and daffodils, crops that really appreciate *warmer* cooling, may actually suffer from a condition of *not receiving enough total cold* for proper flowering. Consider the scenario of hyacinths planted and added to a cooler of tulips at 48F (9C). After 4-5 weeks, the temperature is dropped to 33-34F (1-2C) because tulip root growth was rapid and heavy. While the 33-34F temperature will greatly reduce further root growth of both crops, the hyacinth might not receive enough cold-weeks because 33-34F is a suboptimum temperature for cold accumulation in hyacinth and daffodil. If plants are forced after 14 total weeks of cold, the hyacinths may grow slowly and unevenly, a sign of insufficient cold. Because of this, we have been working on the effects of giving some weeks of warm (48F, 10C) "finishing cold" for hyacinths and daffodils before forcing. More details were presented in the June 2013 newsletter (http://www.flowerbulbs.cornell.edu/newsletter/No%2029%20june%202013.pdf)

Collate Drenches

Readers of this newsletter and followers of the Flower Bulb Research Program are aware that we (Cornell) have been working on ethephon (Florel, Collate) drenches as a height control technique for spring bulbs. The January 2014 Newsletter (http://www.flowerbulbs.cornell.edu/newsletter/no%2031%202014%20january.pdf) has a great deal of information on ethephon drenches for narcissus and hyacinth. While still not labeled, we do anticipate that drenches will become labeled for Collate in the reasonably near future. Our work before the 2014 forcing season was summarized in the January 2014 newsletter. At this point, I can say the results from the 2014 forcing season fully supported and expanded these previous conclusions. We have good dose responses of height to Collate concentration in narcissus and most hyacinth cultivars. A given dose of ethephon (for example, 30 mg/6" pot) can be applied in a wide variety of ways from a heavy spray/sprench to a traditional 4 ounce/6" pot drench, with equal results and effects on the plant (Fig. 11). Thus, growers will ultimately be able to use different application systems and techniques that work best with their facilities and equipment. We also saw effective height control across a range of forcing temperatures, so whether you grow hyacinths and daffodils cool or warmer, Collate drenches will still be an effective height control technique. The 2015 season will see quite a lot of research on the feasibility of multiple ethephon treatments on tulips…we believe there is potential for ethephon use on pot tulips. Stay tuned!

Muscari planting

We learned something new (for us at least) about Muscari (grape hyacinths) this past year. That is, they really do not need to be "buried" when planting. Simply pressing them about ½ way into the planting mix is deep enough, and they do not need foam rubber (as used for hyacinths and daffodils). They will root solidly into the pot. They do not "lift" like hyacinths and daffodils do. This is a nice feature of Muscari, it helps with fast planting and further, when planted this way, produces a product where the bulb tops are visible, and this can add interest and value for the consumer (Figs. 12-13).

Fig. 11. Effect of ethephon (as Collate) drench volume and concentration combinations. Primeur. L to R: Control, 15 ml of 2,000 ppm; 30 ml of 1,000 ppm; 60 ml of 500 ppm; 90 ml of 333 ppm, and 120 ml of 250 ppm. Each treatment delivered the same ethephon dose per pot, (30 mg). Image 8334.

Fig. 12. Muscari (grape hyacinth) planted simply by pressing the bulb into the soil. Cornell trials, 2014. Image 0308.

Fig. 13. Example of value added, top-planted Muscari for winter and early spring sales in Holland. Image 8643.

Fig. 14. Tim Klaver, Cornell Intern for 2014-2015. Here, Tim is beginning to plant landscape trials dealing with planting depth and mulch coverage for tulips. Image 2393.

Tim Klaver, new Dutch intern at Cornell for the 2015 forcing season

Many readers of this newsletter are aware that Cornell hosts a Dutch student-intern each year. The interns arrive in mid-September and work with Bill Miller and his other students to work on all the research that happens in the Flower Bulb Research Program. This year's intern is Tim Klaver (Fig. 14). Many of you might know Ko Klaver of Zabo Plant, Tim is Ko's nephew. Tim grew up on a tulip and lily farm and has good experience with these crops, and bulbs in general. This is actually his second internship in the US as he was an intern last year with Ko. Tim will be with the Research Program through May of 2015. He is currently busy with bulb counting and cooling schedules, planting and record keeping.

Cultivars and PGRs

The website of the Flowerbulb Research Program (www.flowerbulbs.cornell.edu) has an extensive listing of tulip, hyacinth and narcissus cultivars, with suggestions of PGR use. For more than 150 tulip cultivars, information is given on drench rates for A-Rest, Piccolo/Bonzi, and Topflor. This listing has been developed by research at Cornell and by adaption of information on still-used cultivars from the Holland Bulb Forcer's Guide (5th ed.).

2014 Cornell Floriculture Field Day and Eucomis and Agapanthus trials

The yearly Cornell Floriculture Field Day was held August 5 this year. About 125 people attended morning educational sessions on a range of marketing, pest management and plant-oriented topics. The afternoon program featured lunch and time to inspect the extensive annual and perennial trials Cornell manages each summer.

As in past years, the New Zealand-supplied *Eucomis comosa* cultivars (Innocence, Tegula Jade, Tegula Gem) and Dutch-supplied *Agapanthus* (thanks to Piet Zonneveld) were doing very well. The *Eucomis* have now come through two winters and the *Agapanthus* from 3 to 12 winters (depending on the cultivar). Clearly, there is substantial cold hardiness within the small-flowered *Agapanthus* and *Eucomis comosa* assortment. A much more extensive discussion of these trials can be found in the January 2014 newsletter at http://www.flowerbulbs.cornell.edu/newsletter/no%2031%202014%20january.pdf