MARYLAND COOPERATIVE EXTENSION
UNIVERSITY OF MARYLAND
COLLEGE PARK•EASTERN SHORE

Fact Sheet

Fact Sheet 837

Production of Tulips as Cut Flowers

Introduction

Tulips are a refreshing reminder to customers that winter is almost over. Customers' desire for color at the end of winter creates a profitable crop for cut flower growers using minimally heated greenhouses and high tunnels. Tulip bulbs can be forced to bloom out of season (from December through May) for early spring sales at Valentine's Day, Easter, and Mother's Day. Tulip bulbs can also be grown outdoors in raised beds, allowing them to flower naturally for spring sales.

Bulb Selection

The major groups of tulip flower types are simple petal, parrot, fringed, double flowering, multi-flowering, and lily flowering. Fringed and parrot tulips are considered distinct flower types. The fringed types have a regular tulip bloom with a fringed edge. Parrot tulips, however, have a deeper cut in the bloom edge and are more ruffled overall. Double flowering tulips have a cluster of multiple petals forming the flower head. Multi-flowering tulips have more than one flower per stem. Lily flowering tulips have more pointed petals and usually bloom later than any other type of tulip.

Bulbs are measured by circumference (cm) in a horizontal plane at the middle height of the bulb. The ideal bulb size for tulips is top size 12/+ cm, although some growers use a smaller 11/12 cm size. However, for optimum flower production the 12/+ cm top size is highly recommended because smaller bulbs result in a poorer quality crop with smaller flowers and shorter stems. Bulb orders should be placed with suppliers after Mother's Day and preferably no later than the Fourth of July weekend. Most suppliers provide the tulips in trays of 500 per variety for a 12/+ size and 750 per variety on the 11/12 size bulbs.

Precooling Requirements

It is highly recommended that you follow the information provided in the *Holland Bulb Forcer's Guide*–5th Edition (see References section for more information). There are two main types of bulbs, precooled and non-precooled. The *Holland Bulb Forcer's Guide* defines precooling as "the dry storage of spring flowering bulbs at temperatures between 35-48°F after floral initiation and development is completed, but prior to planting." Precooled bulbs need to be planted fairly quickly upon receipt. If precooled tulip bulbs must be stored for a short period, keep them at the temperature specified by the supplier (usually 40-45°F). The second type, non-precooled bulbs, are stored at non-chilling temperatures (typically 63°F) until cooling begins by the final forcer. Non-precooled tulip bulbs can be potted and stored in a dark, cool (33-40°F) barn or shed for 12-14 weeks. Monitor the stacked crates often to prevent the shoots from growing into the crate above.

Production Methods

Greenhouse—Hydroponic in Crates

Reusable water trays are placed in tulip bulb shipping crates. The trays float in a liner that is inserted in the bulb crates. Two kinds of water trays are commonly used—the egg crate type and the prong type. The prong-type water trays are able to accommodate bulbs of various sizes,

Table 1. Tulips for Field Production—Grouped by Flowering Period.

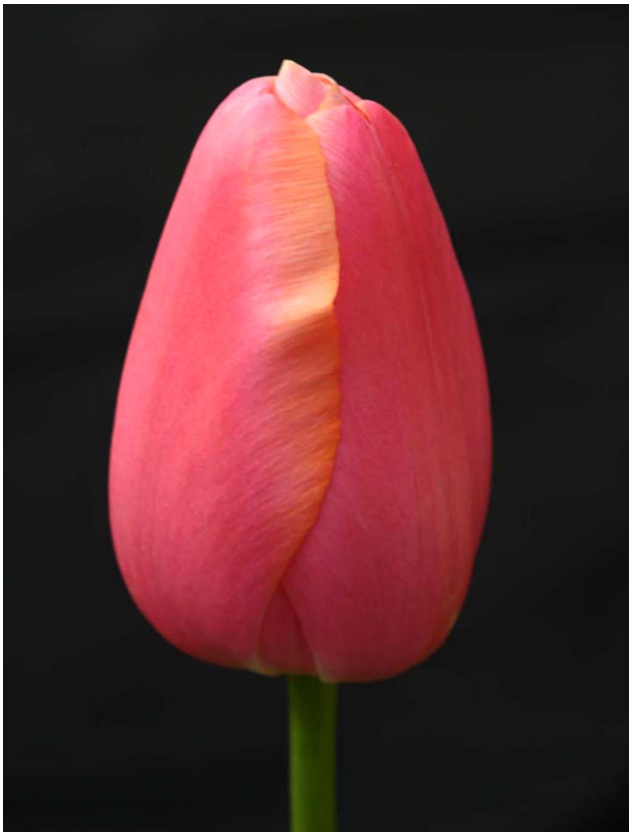
Variety	Color	Natural Flowering Season
Pink Impression	Pink	early
Red Impression	Red	early
Van Eijk	Pink	early
Othello	Purple	early
Bastogne	Red	early/mid
Bastogne Parrot	Red parrot	early/mid
Oxford	Red	early/mid
Oxford Elite	Orange/yellow	early/mid
Apricot Parrot	Apricot parrot	mid
Ben van Zanten	Red	mid
Blushing Beauty	Yellow, red blush	mid
Don Quichotte	Pink	mid
Golden Oxford	Yellow	mid
Gwen	White	mid
Jan van Nes	Yellow	mid
Laura Fyji	Red/yellow	mid
Leen van der Mark	Red/white	mid
Lucky Parrot	Red/white parrot	mid
Negrita Favourite	Purple	mid
Barcelona	Pink	mid/late
Strong Gold	Yellow	mid/late
Synaeda Blue	Lavender/white	mid/late
Avignon	Orange	late
Big Smile	Yellow	late
Flaming Parrot	Yellow/red	late
Grand Style	Red	late
Ile de France	Red	late
Lady Margot	Yellow	late
Maureen	White	late
Menton	Salmon/pink	late
Mrs. JT Scheepers	Yellow	late
Purple Lady	Purple	mid
Renown	Pink	late
Texas Flame	Yellow/red	late
Texas Gold	Yellow	late
Queen of Night	Black	late
Clearwater	Pure white	very late

whereas the egg crate type comes in two different sizes to hold a particular size bulb.

Precooled bulbs are required for greenhouse forcing. Precooled bulbs are planted into the hydroponic trays and typically placed back into a cooler at about 40°F for 1-3 weeks depending on cultivar and time of year. This temperature allows for some rooting to take place before the bulbs are placed in the greenhouse for forcing. The tulips can then be grown in a cool (40°F night) or warm (55°F night) greenhouse. The warmer the greenhouse, the faster the bulbs will bloom.

Level benches are needed so that the water level is the same for the entire crop. Water is added to the trays so that the level of the water just touches the bottom of the bulbs to initiate root growth. Some bulb suppliers recommend removing the paper skin from the base of the bulb to allow faster root growth, being careful not to damage the root area.

The water in the trays should be changed several times during the growing cycle, either by overflowing the crates when watering or completely changing the water. Be aware that dumping excess water on the greenhouse floor



Simple Petal Flower Type–'Dordogne'- Zabo Plant.

Table 2. Tulips for Greenhouse Production—Grouped by Flower Type.

		Suitable Forcing Periods			
	Color	January	February	March	April
Double early tulips					
Abba	red	x	x	x	x
Holland Ballet	white	x	x	x	x
Largo	red	x	x	x	x
Margarita	lavender	x	x	x	x
Monte Carlo	yellow	x	x	x	x
Mondial	white	x	x	x	x
Double late tulips					
Abigail	dbl Attila		x	x	x
Angelique	soft pink		x	x	x
Don Camillo	dbl Don Quichotte			x	x
Mount Tacoma	white		x	x	x
Upstar	pink		x	x	x
Fringed tulips					
Arma	red			x	x
Curly Sue	purple		x	x	x
Louvre	pink	x	x	x	x
Madison Garden	deep pink		x	x	x
Parrot tulips					
Apricot Parrot	apricot		x	x	x
Erna Lindgreen	red	x	x		
Flaming Parrot	red/yellow flame			x	x
Prof. Rontgen	orange		x	x	x
Rococo	red			x	x
Salmon Parrot	salmon		x	x	x
Texas Flame	yellow/red flame			x	x
Texas Gold	yellow			x	x
Webers Parrot	pink/white base		x	x	x
Multi-flowering					
Cloud Nine	pink		x	x	x
H.D. Genscher	crème			x	x
Silhouette Bouquet	red		x	x	x
Regular cut tulips					
Ad Rem	orange/yellow edge		x	x	x
Attila's Record	lavender		x	x	x
Barcelona	pink		x	x	x
Baronesse	pink			x	x
Bastogne	red	x	x	x	
Ben van Zanten	red	x	x	x	
Bright Pink Lady	soft pink	x	x		
Café Noir	dark purple			x	x

	Color	Suitable Forcing Periods January	February	March	April
Regular cut tulips					
Carola	pink		x	x	x
Cassini	red	x	x		
Charmeur	red/white			x	x
Cheers	crème	x	x	x	x
Cherida	crème yellow	x	x	x	x
Clearwater	white		x	x	x
Deshima	red	x	x	x	
Don Quichotte	pink		x	x	x
Dynasty	pink/white base	x	x	x	x
Dreaming Maid	lavender/white			x	x
Early Glory	pink		x	x	x
Friso	red	x	x	x	x
Gabriella	soft pink	x	x	x	x
Gander	pink	x	x		
Gander's Overture	crème/pink flame	x	x		
Gander's Rhapsody	pink/white base	x	x		
Golden Brigitta	yellow	x	x		
Happy Generation	white/ red flame		x	x	
Holland Beauty	pink	x	x	x	
Ile de France	red	x	x	x	x
Jack Pot	dark purple/white		x	x	x
Jan Reus	burgundy red		x	x	
Jan van Nes	yellow	x	x	x	x
Kais. Maria Theresia	soft pink	x	x		
Kees Nelis	red/yellow		x	x	x
La Nouba	white	x	x	x	x
Leen vd Mark	red/white	x	x	x	
Leo Visser	red/white	x	x	x	
Lucky Strike	red/white	x	x	x	x
Negrita	purple	x	x	x	
Negrita's Favourite	purple	x	x	x	
Niigata	pink		x	x	x
Orange Cassini	orange	x	x		
Othello	purple	x	x		
Peerless Pink	pink		x	x	x
Pink Impression	pink			x	x
Prima Vista	red	x	x		
Primavera	pinkish-red	x	x		
Purple Flag	purple	x	x	x	x
Purple Prince	purple	x	x	x	
Red Gander	red	x	x		

		Suitable Forcing Periods			
	Color	January	February	March	April
Regular cut tulips					
Red Impression	red			x	x
Rosalie	pink		x	x	x
Royal Virgin	white		x	x	x
Sevilla	red		x	x	x
Shirley	white/purple edge			x	x
Silver Dollar	white	x	x	x	
Stargazer	red/white	x	x		
Strong Gold	yellow		x	x	x
Swinging World	pink		x	x	x
Synaeda Blue	lavender/white		x	x	x
Synaeda Show	white		x	x	x
The Mounties	watermelon red		x	x	x
Washington	yellow/red flame	x	x	x	x
White Dream	white		x	x	x
White Flight	white	x	x		
World's Favourite	orange		x	x	x
Yokohama	yellow	x	x	x	x

Parrot Flower Type–'Flaming Parrot'- CNB- Holland.

increases the humidity in the greenhouse, thereby increasing the chance of *botrytis* problems.

Greenhouse—Soilless Substrate in Crates

The shorter tulip bulb crates are more suitable for growing tulips than the taller lily bulb crates. Place a sheet of newspaper in the bottom of the crate to prevent the substrate from falling out the bottom. Fill the crate with about three inches of moistened substrate. Tulips produce roots at the base of the bulb, so the amount of substrate under the bulb is more important than the depth the bulb is planted. Arrange the bulbs on the substrate in ten rows of six bulbs, or sixty bulbs per crate. The number per crate can vary by bulb size, with as many as 100-105 11/12 cm bulbs being used in some cases. Cover the bulbs with 2-3 inches of substrate and then water well. Tips of the bulbs should still be visible after watering the substrate.

If the bulbs previously received their entire precooling period, then forcing may begin by moving the crates into a cool (40°F night) or warm (55°F night) greenhouse, or holding in a cool area several weeks to grow roots. If coolers are available, bulbs are planted then cooled at 40°F (or below to reduce shoot

Table 3. Production Methods.

Site	Method	Precooled	Non-Precooled	Time of Year to Plant
Greenhouse	water trays	yes	no	fall season
Greenhouse	soil in crates	yes	no	fall season
Greenhouse	raised bed	yes	no	fall season
High tunnel	raised bed	no	yes	late fall, early winter
Field	raised bed	no	yes	late fall, early winter

growth) for a total duration of 12-16+ weeks depending on the cultivar and time of year. After cooling, forcing may begin. Protect the bulbs from freezing. Keep the substrate moist at all times, while being careful to keep the foliage as dry as possible when watering.

Greenhouse—Raised Beds

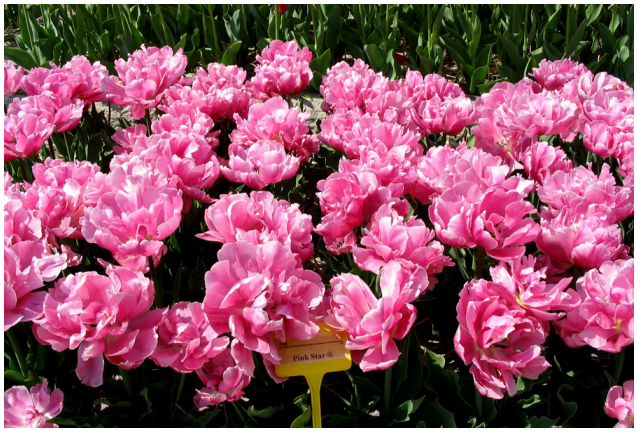
An indoor, raised bed can be constructed using pressure treated wood to create six-inch high sides. When constructing raised beds in a high tunnel or greenhouse, consider the space between the beds for maneuvering equipment.

Raised beds are useful for tulip production because they help to improve drainage and prevent disease problems caused by root rots. Do not replant in beds that have had tulips in the past unless you are able to steam sterilize the substrate at 160–180°F for 30 minutes. During the heat of the summer when a greenhouse is not in use, plastic covers can be used to solarize (using the sun to heat the soil) the beds for 4-6 weeks.

Fringed Flower Type—'Fringed Elegance' - Zabo Plant.

Growing tulips in raised beds is very similar to greenhouse production of tulips in crates

Multi-flowering Type—'Silhouette Bouquet'-Ko Klaver.



Double Flowering Type—'Pink Star'-Ko Klaver.

Lily Flowering Type—'Ballade'- Zabo Plant.

Egg Crate Type Water Tray and Liner- Suzanne Klick.

Field Production of Tulips—Bulbs Placed in Trench- David Dowling.

of soilless substrate. Programmed bulbs are used and planted in steam-sterilized soil. Keep the beds well watered and the greenhouse nighttime temperatures between 40 and 55°F. The warmer the house is kept, the shorter the crop time, but the higher the heating cost.

Field Production

It is easier to plant tulips by digging a trench than it is to plant the individual bulbs. To form a trench, cultivate the planting area 12 inches deep and then shovel the soil to one side of the bed. In field production, tulip bulbs can be planted up to eight inches deep. The deeper the bulb is, the longer the stem will be when pulled at harvesting. If a deeper trench is needed, cultivate the area again and remove more soil.

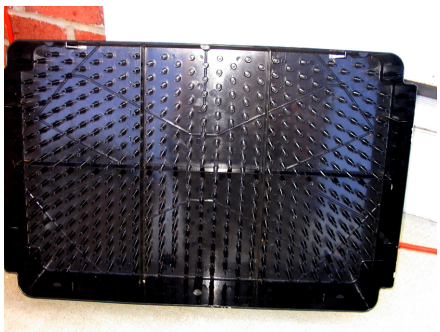
Place the bulbs in the bottom of the trench 6-8 inches deep, leaving about as much space between each bulb as the size of the bulb itself. Cover with soil, being careful not to overturn the bulbs in the process. The loosened soil can be used to create a raised bed over the tulip bulbs. Water the bed well. A preemergent herbicide can also be applied at this time to prevent winter and early spring weed germination.

Low tunnels can be constructed over field grown tulips in early February to force the bulbs into flower in late March, three to four weeks before other field tulips. For information on how to construct a low tunnel, contact the University of Maryland Cooperative Extension or visit the Pennsylvania State University's Center for Plasticulture website at http://plasticulture.cas.psu.edu/.

Low tunnels will also help to protect early crops from deer. Later crops can be protected by placing posts along the sides of the bed and using row cover vertically along each side of the row. Rope zigzagged down the row will support the row cover above the tulips. If the row cover rubs the flowers, the buds will be damaged.

Fertilization

Proper fertilization for tulips used as cut flowers is important. Tulips are not consid-



Prong-Type Water Tray- Zabo Plant.

Hydroponic Crate Production—Bulbs Just Placed in Water-Ko Klaver.

Hydroponic Crate Production—Bulbs Sprouting- Stanton Gill.

ered high feeders, and the bulbs themselves store many nutrients for the plants' initial growth. Excessive fertilization can lead to reduced plant height, which may affect marketability. The use of slow or controlled release fertilizers is not recommended as the plant will be harvested before most of the nutrients are released. For field production, use 1.5 pounds of nitrogen per 1,000 square feet at planting, making sure not to allow the fertilizer to come in contact with the bulbs. After bulb emergence in the spring, the application of one pound of actual nitrogen per 1,000 square feet (1.6 oz per 100 sq ft) of row is recommended. The substrate should have a pH of 6.2 to 6.8 for the greatest nutrient availability and plant growth. Adjust phosphorus and potassium to the optimum range based on results from soil tests.

In greenhouse and high tunnel production fertilization should begin after shoot emergence. When the shoots are 2 to 2.5 inches tall use a fertilizer with a 2:1 ratio of calcium nitrate to potassium nitrate after amending the substrate for phosphorus and potassium. Weekly application of this ratio can be used, or a fertilizer injector can be utilized to supply 200 to 250 ppm of N on a constant basis using a well-balanced fertilizer (either 2:1:1 or 3:1:1 nitrogen to phosphorus to potassium ratio) that includes a small amount of phosphorus and potassium. With a soluble salt meter, use the 1:2 dilution method to monitor the electrical conductivity. Acceptable readings should be between 1 and 1.5 mS/cm (mmhos/cm).

Harvesting and Postharvest Handling

Tulips are harvested when petals show color, but are not completely colored or open. When harvesting, tulips can be cut or pulled. Crate-grown tulip stems are cut at harvest time. Tulips grown in the field are pulled at harvesting to increase the stem length. If the soil is soft, the bulb usually comes up when the stem is pulled. When pulling tulips, grasp the stem at the soil line and pull straight up. The stem should snap off at the bulb, producing a longer stem. The used tulip bulbs should be discarded after harvest. This pulling method removes the used bulbs from the bed, making bed preparation for the next cut flower species easier. Rotating tulips to another field the following year will help to reduce disease occurrence.

The stems of pulled tulips should be cleaned after picking. Simply swish a handful of stems in a large bucket of water to clean the soil off the stems before placing them in a bucket of water with preservative. If the tulips experience wilting after harvest, any bent stems must be wrapped or somehow supported in the bucket while rehydrating. Otherwise, they will remain bent even after being properly hydrated. Tulips can be stored in a cooler in water or dry at 35°F for up to one week. If stored dry, they must be supported when rehydrating. Tulips continue to grow after cutting, up to six inches after placing them in a vase.

Pests

Aphids

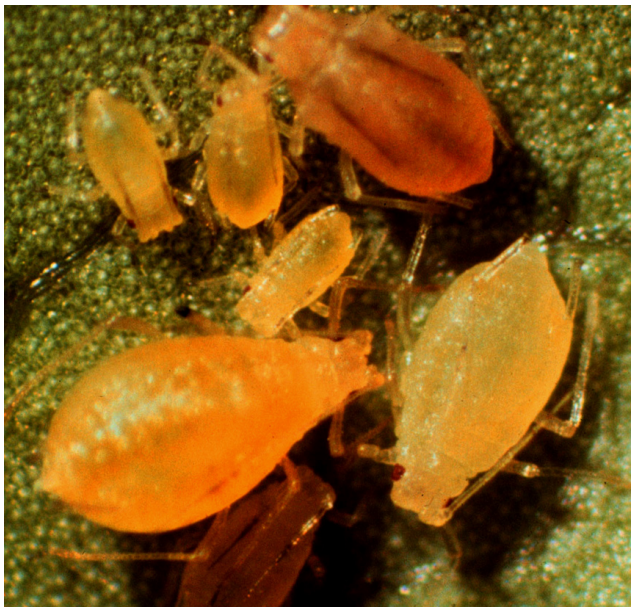
Tulips are relatively pest free but aphids can become an occasional problem, especially for greenhouse-forced crops. The two major species of aphids found in greenhouses on tulips are melon aphid (*Aphis gossypii*) and green peach aphid (*Myzus persicae*).

Aphids can rapidly become a major pest if left unchecked. Because aphids feed on the plant fluids within the phloem of leaves and green stems, they represent a competing nutrient sink. Heavy aphid populations may measurably reduce plant vigor. Aphids also excrete large quantities of sugar-rich honeydew on which sooty mold fungus may grow.

Before any attempt is made to control aphids, it is necessary to identify the species. Submit samples of aphids to your local Cooperative Extension office for identification. After the species is identified, familiarize yourself with its biology on the tulip crop. Note whether it prefers particular species or cultivars of tulips, if it feeds selectively on certain parts of the plant, and how rapidly it reproduces.

Green peach aphid (*Myzus persicae*)

The color of green peach aphid can range from light green to yellow to gray-green to pink or even reddish. It is a fairly large aphid that most people can see without magnification. The green peach aphid has a pronounced indentation between the base of the antennae



Green Peach Aphids- Stanton Gill.

on the front of the head. The cornicles (two projections on the rear of the aphid) are long and slender. The color of the cornicles matches the body color of the aphid but the tips of the cornicles are black. This aphid can reproduce very rapidly and populations can explode in a very short time. Control should be attempted early before populations become large.

Melon aphid (*Aphis gossypii*)

The melon aphid is slightly smaller than the green peach aphid but it reproduces just as quickly. Both melon aphids and green peach aphids have been found to transmit viruses. The color of the melon aphid depends upon its food source. They may vary from slightly green to dark green to various mottled shades of green or even yellow. The antennae are shorter than the length of the body and there is no indentation between the base of the antennae, as found with the green peach aphid. The cornicles of the melon aphid are short and very dark colored.

Insecticidal soaps offer some control against aphids. Applications should be applied at regular intervals for maximum efficacy. Growers that have problems with aphids can also apply foliar or soil drenches of a labeled neonicotinoid. Check the University of Maryland Cooperative Extension's Bulletin 363, "Total Plant Management for Greenhouse Production," to select a recommended systemic pesticide.

If you grow tulips in greenhouses, check the plants before moving them indoors to

Melon Aphid- Michael Hoffman.

make sure they are free of aphid populations. Control weeds under the greenhouse benches and directly outside the greenhouse to prevent aphid populations from developing. Aphids can be prevented from migrating into the greenhouse by covering screen vents and doors with a 300-holes-per-inch mesh screening.

Diseases

Major diseases of tulip in Maryland include tulip fire (*Botrytis tulipae*), bulb/basal rot (*Fusarium oxysporum* f. sp. *tulipae*), bacterial soft rot (*Erwinia carotovora*), blue mold (*Penicillium* species), root rot (*Pythium* species), nematodes, and viruses. Starting with disease-free stock is always the most important step in the growing process. Bulbs should be purchased from a reputable dealer. Most large bulb producers regularly check stock for viruses and other diseases. Inspect bulbs carefully upon arrival and have suspicious material examined by a lab. The presence of diseases may warrant the rejection of a shipment.

Preplanting Treatments

Bulbs may be dusted or dipped in fungicides such as thiram (available under many trade names) or thiabendazole (Mertect), to help control diseases such as *Fusarium* basal rot and *Penicillium* blue mold.

***Botrytis* (Tulip Fire)**

Tulip fire is caused by the fungus *Botrytis tulipae* and is the most common disease of tulips during production and in the landscape.

Initial symptoms include light tan patches on tulip leaves. These patches are most noticeable on light-colored varieties. Leaves become flecked with small brown (necrotic) spots. Spots enlarge and coalesce to form large brown patches and cause blight of entire flowers or leaves. Flowers also frequently become infected and display flecked brown to white spots. On colored petals spots appear white and on white petals they appear brown. Under conditions of high humidity, necrotic spots on leaves, stems, and flowers are accompanied by sporulation of the brown-gray fungus. Further infection occurs very rapidly once the fungus begins sporulation; this is the origin of the name "tulip fire." Infection can also lead to the collapse of leaves, stems, and flowers.

The outer bulb scales may also become infected and display yellow to brown, sunken, circular lesions. Small, black sclerotia (resting structures of the fungus) may be found developing on rotting leaf, flower, stem, and bulb tissue.

Control: Bulbs should be carefully inspected by removing the outer husks of the bulb and discolored or spotted bulbs should be discarded before planting. Plantings should be inspected regularly; early detection and hand-rouging is essential for controlling this disease. While inspecting plants, carry a bag for diseased materials. As soon as the disease is detected in a bed, affected plants or parts should be removed. Remove faded or blighted flowers, blighted leaves, or entire plants infected at the base and place them in the bag. Discard infected parts with the trash or burn them. It is best not to remove material when plants are wet because fungal spores (conidia) could be spread during conditions that favor disease development. Entire plants should be removed including the bulb portion below ground if infection is observed at the base of the plant. Overhead irrigation and crowded plants can increase disease incidence. During rainy springs when conditions favor disease development, applications of fungicides may be useful when new growth emerges in the spring. Fungicides should also be used if infections occurred in the previous year. Compounds currently registered for use in Maryland include carbamic acid, chlorothalonil, copper hydroxide, iprodine, and mancozeb. (Always consult the label for dosage rates and safety precautions.)

Bulb and Root Rots

Erwinia carotovora

Infected plants fail to flower or blossoms fall off before they open. Tops may appear water-soaked and collapse. Infected bulbs have a strong odor and are soft and mushy.

Phytophthora cactorum and Pythium species

Bulbs develop soft, gray spots with brown borders near the base of the bulb. Shoots may fail to emerge. If bed has a history of *Phytophthora* or *Pythium* infection, then chemical or steam-pasteurized potting mix will be required.

Control: Site management is important for controlling bulb and root rot diseases caused by *Erwinia*, *Phytophthora*, and *Pythium*. These pathogens are favored in moist, shaded areas with poor air circulation and poor drainage. These diseases are highly contagious and control requires the removal and destruction of all infected bulbs. Remove and destroy symptomatic foliage and plant debris in the fall after the tops have been killed by frost. Bulbs should be planted in well-drained soil and watered early in the day. These diseases may also be minimized by avoiding overcrowding and wounding during cultivation. Sanitation is also very important. All equipment should be disinfested between use with 10 percent household bleach, 70 percent alcohol, or one of the commercially available compounds. It is also helpful to control insects and mites because injuries associated with their activity provide sites for infection.

Storage Rots

Fusarium oxysporum var. *tulipae* and *Penicillium* species are two diseases affecting tulip bulbs during storage. These diseases are also associated with mechanical injury or damage from mites. Infection is favored by moist conditions. Infected bulbs have a dry rot and bulb scales are often covered with the characteristic blue-green (*Penicillium*) or pink (*Fusarium*) colored growth of the fungus.

Normally, *Fusarium* infections begin in the field and continue during postharvest storage. There are substantial differences in cultivar susceptibility, but it is important to reduce the number of infected bulbs in storage because of the ethylene they produce. This can lead to flower abortion and abnormalities.

Control: Producers need to dig carefully in order to avoid wounding the bulbs. Wounds provide natural entry points for pathogenic fungi. It is also helpful to control insect and mite pests. Producers and suppliers should cull and destroy infected bulbs prior to storage. Bulbs in storage must be routinely inspected and the rooms monitored for ethylene. Levels in the storage rooms must not exceed 0.1 part per million. In storage, *Penicillium* can be controlled with high rates of ventilation and by maintaining a relative humidity of 85 to 90 percent. Tulip bulbs should always be shipped at 63°F (~17°C) under a ventilation rate of 150 m3 h-1. With the exception of a 93°F (~34°C) treatment for early forcing (a process normally completed by the supplier), nonplanted bulbs are never stored above 77°F or below 32°F (> 25°C or < 0°C).

Nematodes

Stem and bulb nematode (*Ditylenchus dipsaci*) is the major species affecting tulip. On tulip, infestation is best detected at flowering. The initial symptom is a pale or purplish lesion on one side of the stem immediately below the flower, which bends in the direction of the lesion. The lesion typically increases in size both downward and upward often on to the petals. The bulbs do not show brown rings as with narcissus and hyacinth when cut across. Infestations start at the base of new bulbs. Upon removal of the outer brown scale, soft grayish or brownish patches can be observed on the outer fleshy scale. Nematodes move out of decayed bulbs into the soil where they overwinter. They may then move into healthy bulbs the next spring. Nematodes require lab tests for identification.

Tulip Bulbs with Penicillium Fungus Growing on Top-Ko Klaver.

Control: No nematicides are currently labeled for use on tulips in Maryland. Stem and bulb nematode is best controlled by prevention. Many areas (especially Europe) have established legislative laws for *Ditylenchus dipsaci* as a significant quarantine pest. If infected bulbs are found in a shipment, destruction of the entire contents of the shipment may follow. Hot water treatments for tulip bulbs have been quite effective in controlling nematode problems, but this type of treatment jeopardizes bulb vitality. Many growers report that numerous losses of tulip occur when using hot water treatment to control nematodes.

Viruses

Viruses known to infect tulip include tulip breaking virus, tobacco necrosis virus, tobacco rattle virus, tobacco mosaic virus, and cucumber mosaic virus. Symptoms of infection consist of stripes or streaks of white or another color in the normal colored petals. A classic example of a virus-infected tulip variety is the "Rembrandt tulip." Modern tulips exhibiting similar streaking characteristics no longer contain the virus. Leaves of virus-infected plants may appear distinctly mottled. Viruses are persistent in the bulbs and are often transmitted from plant to plant by aphids, especially in situations where plants are crowded and heavily infested.

Control: Bulb suppliers regularly inspect and test for viruses during production. Viral diseases are difficult to control so prevention is a major factor for control. Infected plants and bulbs should be removed and destroyed to minimize spread of the virus. Control of the aphid vectors is also important. Weeds can also harbor various viral diseases and other diseases; therefore it is important to control weeds in and around production areas.

Physiological Disorders

Frost injury—Frost damage may appear as oblong to oval spots along the veins of the leaves. This injury is not common.

Retarded growth—A result of storage under excessively warm conditions or if bulbs are not fully ripened. Growth may be retarded or suppressed completely.

Sunscald—Occurs in sunny, dry conditions and results in the scorching of flower parts, particularly along margins.

Topple—Some varieties develop water-soaked spots and exude liquid from the main stem. Eventually flowers collapse. This problem is thought to be due to insufficient ripening of the bulb, especially after wet, cool summer weather and by forcing bulbs in compact soils or at high temperatures.

Control: Prevent high temperatures and premature forcing especially after wet, cool years. If this is a problem, try a different variety that may be less susceptible to this disorder.

Winter injury—If bulbs are planted too late in the fall in compact, poorly drained sites, roots cannot establish and bulb decay occurs. Shoots may appear abnormal and distorted—be sure to check below-ground portions to examine root development.

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