

Crop: Tulip
Scientific Name: Tulipa gesneriana (Liliaceae)

I. Introduction

- A. Tulips are distributed from the hilly region of Asia Minor, to the southern Caucasus, Turkistan and Bukkara. They persist into China and Japan and westwards to the northern Mediterranean and Portugal.
- B. Plants are generally found in hilly country with extremely cold winters and hot dry summers.
- C. Most bulbs produced for commercial forcing are grown in The Netherlands.
- D. Bulbs are dug in the summer and then shipped by boat prior to distribution in the U.S. Bulbs - buds surrounded by scaly fleshy leaves (starch storage organ).
- E. Plants are forced both for cut flowers and potted plants. Major marketing periods are Valentine's day and Easter.
- F. Bulbs are biocomputers and are never dormant. They continuously monitor their environment.

II. Species, Cultivars, Breeding, Development

- A. Many tulip cultivars are available. Registered names can be obtained from "The Classified List and International Register of Tulip Names". It is revised from time to time.
- B. Extensive research by A.A. De Hertogh has resulted in the "Holland Bulb Forcer's Guide" which lists cultivars and their requirements for greenhouse forcing. It should be used as a guide for cultivar selection.
- C. Cultivars are available for forcing from mid-December to early May.
- D. Red is the primary color. Color mix varies with market and holiday crops for Valentine's Day are almost 100% red. Easter crops may be 60% red, 15% red with white, 5% yellow, and 5% misc. colors.

III. Flower Induction Requirements

- A. When bulbs are harvested, the apical meristem is vegetative.
- B. Flower initiation and subsequent development are controlled by postharvest warm temperatures.
- C. For bulbs to be forced early in the season, bulbs are harvested in mid-to-late June and treated for 1 week at 34°C (93°F). They are then placed at 20°C (68°F) until early August and then 17-18° C (63-65° F) until mid-season when the flower bud reaches stage "G". Bulbs are then given 6 weeks of 7-9°C (45-48°F) temperatures prior to planting.
- D. For midseason forcing (Valentine's Day), bulbs are dug in late June or early July and held at 17-20°C (63-68°F) until planting.
- E. For late season forcing (Easter), bulbs are harvested in July and are stored at 23°C (73°F) until September 1, 21°C (70°F) until October 1, and then 17°C (63°F) until potting.
- F. All forcers should check bulbs of all cultivars to be certain they have reached "G" stage prior to planting. If they have not reached "G" stage, they should be held at 17°C (63°F) until they do.

IV. Environmental Requirements

- A. Light
 - 1. Light intensity is not as critical in forcing tulips as in many other flowering crops.
 - 2. Light functions to control elongation and to provide for a high quality plant.
 - 3. For early forcing dates, plants can be left in the dark until the lowest internode becomes visible. This helps increase plant height on plants which tend to be short.
 - 4. No photoperiodic responses are observed during forcing.

B. Temperature

- 1. The most critical environmental factor involved in forcing tulips is temperature.**
- 2. There are three distinct phases in which temperature must be controlled by the forcers. They are: 1) the post-shipping period; 2) the cold storage; and 3) greenhouse forcing period.**
- 3. Post-shipping period:**
 - a. This period is from arrival of the bulbs until planting.**
 - b. For bulbs which have not yet reached stage "G", place at 17°C (63°F).**
 - c. For bulbs used in early forcing which are precooled, place at 7°C (45°F) for Pot Tulip Period 1 (flower January 1-15) and 9°C (48°F) for Pot Tulip Period 2 (Flower January 20-February 5) after they have reached "G" stage.**
 - d. For bulbs which are not precooled, i.e. used for standard forcing, place at 17°C (63°F).**
 - e. For bulbs which are to be "Special Precooled", place at 13°C (55°F) after "G" stage is reached, and at 5°C (41°F) during precooling (starts September 20 to September 30, depending on cultivars).**
 - (1) Special Precooling is a process of forcing bulbs directly for Valentine's Day after the bulbs have received their cold treatment. Bulbs receive the cold treatment prior to planting.**
 - (2) These bulbs are primarily used for cut flowers.**
- 4. Cold Storage**
 - a. This period is from planting until bulbs are placed in the greenhouse. The cold period varies from 15 to 23 1/2 weeks, depending on cultivars and forcing date.**

- b. Bulbs are potted at different times for different flowering dates. Flowering dates vary from Jan. 1 through May 8, an 18 week time period.
- c. Bulbs receive a cold treatment so that rapid plant development occurs when placed in the greenhouse.
- d. Two rooting rooms are used, A and B.
- e. Temperature sequences are as follows:

Temperature	Rooting Room	
	A	B
9°C (48°F)	Plant till Nov. 5-10	Plant till Dec. 5-10
5°C (41°F)	Nov. 5-10 till Jan 1-5	Dec. 5-10 till Jan 1-5
0-2°C (32-35°F)	Jan. 1-5 to finish	Jan. 1-5 to finish

- f. The "Holland Bulb Forcer's Guide" should be referenced to determine which bulbs are placed in each room (based on cultivar and potting date).
- g. Temperatures are maintained at 9°C (48°F) until roots are growing out of the pot bottom. This means the temperature may be lower earlier or later than the indicated date. Complete rooting is important.
- h. Temperatures of 5°C (41°F) are maintained until the tulip shoot is about 5 cm (2 inch) tall. This means that the temperature may be lowered earlier or later than January 1-2.

5. Greenhouse forcing

- a. Time to flower of bulbs is dependent on greenhouse temperature.
- b. In January and February, 21-25 days are required at 18°C (65°F), 28-32 days at 16°C (60°F), and 35-39 days at 13°C (55°F).

- c. Average forcing time will decrease as the season progresses.
- d. For flowering dates up through March 15, best temperatures are 17°C (63°F) night and 20°C (68°F) day. After March 15, slightly lower temperatures are better.

C. Water

1. The growing medium should always be moist.
2. Moisture is required for rooting. Therefore, pots must be monitored and watered as necessary during the cold storage phase.
3. Adequate water is also necessary during forcing.

D. Nutrition

1. Tulips force rapidly, have nutrients in the bulb, and therefore have very low nutrient requirements.
2. Plants should be fertilized with 2 lb Ca(NO₃)₂ per 100 gallons water once or twice during forcing.

E. Gases

1. The primary gas of concern is ethylene.
2. Utmost care must be taken to avoid exposing bulbs to ethylene during shipping, storage, and forcing.
3. Bulbs should not be stored with ripening fruits or vegetables, near running internal combustion engines, or near natural gas.
4. Bulbs infected with *Fusarium* produce ethylene. Such bulbs should be discarded immediately when found and never planted. Infected bulbs can cause flower bud abortion and other abnormalities in bulbs planted nearby or in the same pot.

V. Cultivation

A. Propagation

1. Tulips are a tunicate bulb. As propagation is not a concern to greenhouse forcers, individual interested should read Rees (1972).
2. For pot forcing bulbs 12-13 cm in circumference should be used as smaller bulbs will produce small flowers.

B. Medium and Planting

1. The planting media should be sterile, well drained, have a pH of 5.5 to 7.5, and have a low soluble salt level.
2. Five bulbs are planted per pot. Bulbs are placed near the pot edge with the flat side of the bulb pointing out. The first leaf will unfold from the flat side and will then point of the pot.
3. Bulbs should be planted with the bulb tip just showing above the medium.

C. Spacing

1. Pots can be spaced pot-to-pot during forcing.
2. Care should be taken to ensure adequate ventilation to prevent diseases.

D. Support

1. None required unless plants stretch excessively.

E. Growth Regulators

1. Ancymidol (A-Rest) effectively controls height.
2. Application rates vary from 0.125 mg per pot to 0.5 mg per pot. Date of application and cultivar contribute to the differences. Consult the Holland Bulb Forcers Guide for specific cultivar recommendations.
3. Soil must be moist when drench is applied.

4. Application should occur within the first 2-3 days after plants have been placed in the greenhouse.

VI. Problems

A. Insects

1. Aphids are the only insect generally encountered. They can be controlled by many insecticides.

B. Diseases

1. *Fusarium*. This disease attacks the tulip bulb. It can be identified by a white mold growing on the outer brown skin (tunic) of the bulb, by a soft bulb or very light weight bulbs. All infected bulbs should be discarded. If more than 10% of the bulbs are infected with *Fusarium*, consideration should be taken towards discarding the entire lot. This is because ethylene damage could have occurred to the non-infected bulbs.
2. *Pencillium*. This disease can be identified by a blue mold growing on the bulb. It generally is not detrimental to the bulbs. Control with suitable fungicides.
3. *Botrytis*. This is the most prevalent disease and can attack the bulb, foliage and flowers. Sanitation and fungicides will control this disease.
4. *Rhizoctonia*. This disease attacks the tulip shoot after planting. Sterile planting medium and fungicides will control it.
5. Viruses. Several viruses attack the bulbs. The viruses are carried in the bulb and forcers have no control over them.

C. Physiological

1. Flower bud abortion. Many factors can cause abortion such as high temperature, ethylene, water stress, and the lack of ventilation during dry storage. It must be analyzed carefully to determine the exact cause.

2. **Flower blindness.** This is when flowers fail to develop in the bulb. The exact cause is unknown but has been associated with very large bulbs (14 cm (5 1.2 inches) and larger). Therefore, bulbs no large than 12-13 cm (5 inches) should be used.
3. **Stem topple.** This physiological disorder is characterized by the collapses of a small portion of the stem just beneath the flower just before or after flowering. It is caused by inadequate calcium translocation. It is most common on bulbs which have received excessive cold (number of weeks) and high greenhouse forcing temperatures above 20°C (68°F). Apply of Ca (NO₃)₂ at the rate of 2 lb/100 gallons at start of greenhouse forcing.

VII. Harvesting, Handling, and Marketing

- A. Tulips should be marketed at the first sign of color in the flower. This is necessary as buds develop very rapidly and decorative life is relatively short.
- B. If plants must be stored before marketing, plants must be placed in the cooler before the buds show color.
 1. Do not place in storage with wet foliage.
 2. Temperature should be 0-2°C (32-32°F).
- C. Cut tulips should never be put in water with daffodils.

VIII. Scheduling

A. Standard forcing - March 1 Flowering

Date	Growing Time for Cultural Segment	Cultural Procedures	Temperature
Mid-Aug.		Bulbs arrive	17°C (63°F)
	varies	↓ V	
Oct. 25		Pot bulbs	9°C (48°F)
	6 weeks	↓ V	
Dec. 1-5		Lower temperature	5°C (41°F)
	4 weeks	↓ V	
Jan. 1-5		Lower temperature	1°C (33°F)
	5 weeks	↓ V	
Feb. 8		Start forcing	17°C (63°F)
	3 weeks	↓ V	
March 1		Flower	