Many growers find that applying two plant-growth-regulating chemicals mixed together gives better height control with less risk of phytotoxicity than applying either chemical alone. The exact concentration of chemicals to be used varies, but in general, growers often apply each chemical at half the rate it would be used if used alone.

SUMMARY
Seedling quality is determined first by the genetics of the plant and the conditions under which the seed was produced and stored. However, the seedling grower must manipulate many aspects of the environment to unlock the maximum potential that each seed holds.

Temperate Treatment of Flower Bulbs: Manipulating Flowering Times©

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WINTER BULBS

In order to understand how the flowering time of bulbs can be manipulated, it is critical to comprehend that bulbs are perennials, and that their life cycle is generated by temperature. Our discussion here is limited to winter bulbs, and they are named thus as they require cold temperature to activate their flowering cycle.

Manipulating Flowering Time. If a commercial grower were to be totally dependent on nature's built-in clock in bulbs, he/she would be forced to flood the market with his/her whole crop of tulip (*Tulipa* sp.) blooms during a single week in springtime and so depress the market price to a catastrophic level. No grower of tulips would survive. This problem cannot be solved by simply planting the tulip bulb earlier or later in autumn, because the bulb is too clever to fall for this trick. It will stubbornly catch up if it is planted too late, or slow down if it is planted too early. It will still flower in that same week in springtime.

In order to fool the bulb we have to do something else. The triggering mechanism that makes the bulb respond to new growth after its resting period is a seasonal change of climate. This sensitivity of the bulb to changes in temperature has to be exploited by the commercial grower in order to get the bulb to flower in a week different from its natural one.

The flower grower will lift tulips bulbs from the ground only at the start of their dormant season in early summer, when the foliage has died down naturally, and the bulbs are full of food. After the bulbs have been washed, graded, and sorted into size groups, they are placed in special chambers in which the air temperature and humidity are carefully controlled. The bulbs are placed in mesh trays so that they can be exposed to forced air ventilation. This is necessary to keep them healthy.

The temperature and humidity in the chamber are designed to mimic nature in the bulb's natural habitat. The natural home of tulips, for example, is southwest Central Asia, and in the normal course of events, the onset of autumn (with a consequent drop in temperature) will set off a response inside the bulb. Root formation will be triggered so that the roots will be ready in time to feed the plant with nutrients and water from the soil during its natural winter and spring growth period.

The tactic employed by the flower grower is to bring winter forward by transferring the bulbs, in batches over time, from their warm resting place into a specific cold temperature. This triggers the necessary response mechanism inside the bulbs. After a predetermined number of weeks at this low temperature, each batch of bulbs is removed from the chamber and planted out in a field. These bulbs now find themselves in soil, which is warmer than the cold-imitated winter temperature they have just left in the chamber. The response of the bulbs is to speed up the growth process to such an extent that they will be in flower long before their normal time.

Through much research, flower growers worldwide have learned the exact temperature to which to subject each individual kind of bulb, and for how long. All this is to make the bulbs flower at predetermined dates. The grower is thus able to supply the market with the same number of blooms each day over a period of many months, by having deliberately advanced the flowering times of the bulbs. This is called forcing.

The method employed to make summer bulbs flower at predetermined times over many months is not to force the bulbs as is done with the tulips, but quite the opposite. Keeping them for longer than normal at the low temperatures at which they naturally hibernate holds summer bulbs back. By keeping batches of summer bulbs cold and planting them at different times in the season, the flowering period can be extended for months.

Forcing Tulips. Of all the flower bulbs, the tulip stands out as the most regal, and its background is as colourful as the flower itself. Tulips originated in the temperate regions of Europe, North Africa, the Eastern Mediterranean, Eastern Europe, and across Asia Minor to the eastern boundaries of China with most of the 100 species from south west Central Asia.

Tulips have been valued throughout history, and were grown in the gardens of the rich and powerful in Turkey many centuries ago. There is record of an order for "50,000 tulip bulbs to be planted in the royal gardens" issued by Sultan Selim II to the Sheriff of Aziz in 1574, and a list of cultivars by Sheik Mohammed Lalizare during the reign of the Sultan Ahmed III (1702-1730) named no fewer than 1323 cultivars. There was, even then, a lively trade in tulip bulbs.

During the peak of tulip trading, during the 17th Century, "Tulip Mania" gripped Holland with the development of "streaked" or variegated coloured tulips. This phenomenon was largely due to a virus infection but this was unknown at the time.

In the 1630s speculation in tulip bulbs reached dizzying heights. Rare cultivars were sold over and over again, unseen and still in the ground. It was pure speculation. People went berserk, selling everything they possessed; houses, farms, everything; giving up their professions and hanging around bars and inns all over Holland, selling parcels of "rare" tulip bulbs which were still in the ground. Individual bulbs were sold or swapped for the equivalent of a large villa in the best part of town. On the 3rd of February 1637 the bubble burst. Suddenly there were no buying bids, only sellers. Thousands of people were financially totally ruined. It was the first ever recorded market crush.

Today tulips and other bulbs are far from the rare commodity they were in the 16th century and present day prices are lower than ever before and keep dropping in real terms, adjusted for inflation. But, tulips are still the "Queens of Flowers". Of all the scores of different types of bulbs available, tulips top the list by far. Commercial growers produce 9 billion bulbs each year, which is more than two bulbs for every human being on the entire planet. Of all these bulbs, 90% are produced in Holland alone! Holland exports about 6000 million bulbs each year, of which nearly 2000 million are tulip bulbs.

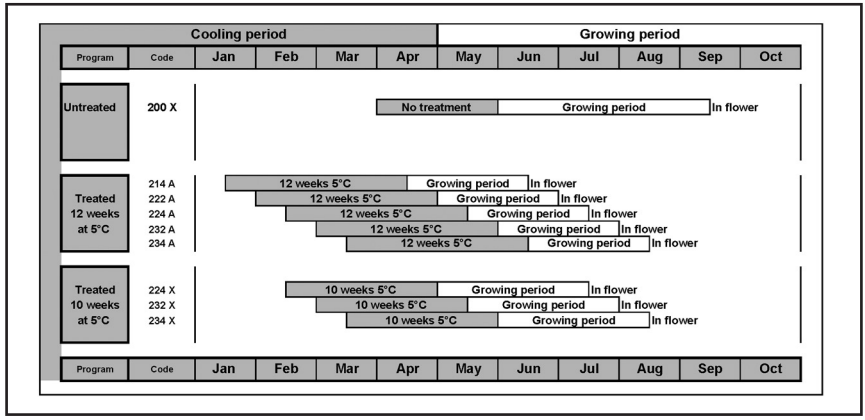

Figure 1. Tulip forcing guide. This figure shows the required cooling and growing periods for several tulip forcing programs. Actual flowering time will depend on prevailing climatic conditions.

It is therefore no surprise that an enormous amount of research has gone into the forcing of tulips for the cut flower market, and our home market is no exception. Our tulip bulbs are farmed at Belfast, Mpumulanga, and at almost 2000 m, it is one of the highest viable farms above sea level in the country. We plant approximately 15 million tulips per annum. Of these, approximately 9 million are in the process of being grown on, and the balance of 6 million is at flowering size (7/+). Of these 6 million, dry bulb sales account for around 800,000, and the balance are destined for our local cut flower market.

With reference to the attached bar chart (Fig. 1) if there were no forcing program, we would flood the market with 5.2 million tulips in the 3rd week of September. Instead, our tulip crop reserved for cut flowers is warmed at 20 ºC after lifting in November, evenly divided into batches, and then cooled for 12 weeks at 5 ºC, between mid January and mid March, before being planted out in batches. Research has shown 12 weeks is the most cost effective period of cold temperature treatment, which provides the shortest consequent growing period, resulting a growing period of just 6 weeks from planting time to harvesting at peak bud stage. Today the program consists of five treatments, allowing our cut flowers to be available on the market at 2-week intervals, from mid June to mid August, or available to growers as treated bulbs between mid April and mid June. In addition, imported tulip bulbs cooled on ice at 0 ºC allow us to offer cut flowers from mid February onwards.

However, 12 weeks of cooling provides almost no shelf life at all for the bulbs after cooling, and while this poses no problem for professional growers, we needed a suitable program for the home gardener. Consequently, we developed a 10-week treatment program at 5 ºC, with a resultant 8-week growing period, providing a 14-day shelf-life, just enough to offer these tulips for sale to home gardeners on a mailorder basis. Currently we operate three such treatment programs, offering treated bulbs for planting at end April, mid May, and end of May, in order to flower end of June, mid July, and end of July. In addition, untreated bulbs may be planted before end of May for September flowering.

All in all, the discovery of temperature forcing of flower bulbs has vastly multiplied viable cut flower businesses across the globe.

ADDITIONAL READING

Barnhoorn, F. 1995. Growing bulbs in southern Africa. Southern Book Publishers, Johannesburg, South Africa.