

The right fertilising and greenhouse climate for best results

Potassium more important than nitrogen

Zantedeschia requires fertilising, but be sure not to apply too much nitrogen in relationship to potassium. Too much nitrogen can increase foliage production, decrease strength, reduce the number of flowers, and increase the risk of culls. The soil also has to provide sufficient quantities of other elements, including trace elements. Simple or compound fertilisers can be applied in various ways including mixing them in irrigation water. For uniform growth, be sure that the amount of potassium is about twice as much as nitrogen. A normal basic dressing can be followed by side dressing later during cultivation.

Conduct weed control before crop emergence

Chemical weed control can be conducted before the emergence of the crop. After emergence, the options are more limited. Once the crop grows together, however, weed control is usually unnecessary. Use care in conducting mechanical weed control in order to prevent damage to leaves and the roots in the upper soil level.

Control temperature and humidity

A greenhouse temperature of 15-16°C is maintained after planting. If possible, keep the soil temperature at 15-18°C. Later during cultivation, once the leaves have unfurled, the greenhouse temperature is usually kept at 18 to 20°C. Depending on the amount of light, the temperature may be allowed to rise to a maximum of 25°C. Try to keep the soil temperature below 20°C to limit the risk of damage from Erwinia. More light benefits flower production and stem quality, so try to make as much light as possible available to the crop during the spring and autumn. Shading with chalk or shade cloths is usually done during the summer to keep both the greenhouse and soil temperatures sufficiently low. Shading under these conditions also prevents the crop, and thus the flower stems, from remaining too short. When the crop comes into flower during the spring and autumn, the greenhouse temperature can be lowered to 15 to 10°C at night. This slows crop development but intensifies flower colour. The best possible RH during the day is 60 to 75%. Never let this drop below 50-60%. Try not to let the RH exceed 75-85% at night. Neither the plants nor the tubers tolerate any frost.

Harvesting the flowers is an art

Harvest flowers on time

The flowers are harvested once they are open and displaying good colour. The right time for this is the day before the flower starts producing pollen. According to the Association of Dutch Flower Auctions, this is stage 3 (see the photo series). The pollen is clearly visible as yellow powder on the spike of the inflorescence. Do not put off harvesting for too long because doing so will shorten keeping quality. Harvesting is best done in the morning when it is easiest to harvest a cool crop saturated with water. Briefly watering the crop very early in the morning makes it easier to harvest the products. When the crop is limp (not fully saturated), harvesting the flowers is more difficult; this leads to an increased risk of pulling not only the main flower from the plant but the second immature one and thus eliminating this one as a usable product.

Proper hygiene pays for itself

Once harvested, place the flowers immediately in a clean pail filled with clean water containing a chlorine tablet. Working with clean pails, clean water and using a bactericide such as a chlorine tablet is necessary to prevent bacterial growth resulting in slimy stems. Put the freshly harvested flowers in a refrigerated chamber set at around 9-13°C. Later, after bunching and trimming the flowers to even their lengths, put them back into clean water containing a chlorine tablet. Store the flowers at 6 to 9°C. Keep the storage time as short as possible; as the flower ages, it will gradually turn green. Always place the flowers upright to prevent them from growing crookedly. Handle the flowers with care to prevent mechanical damage. Processing the flowers also requires clean tables because the flowers can quickly become dirty. In general, adding nutrients for cut flowers to the water will have very little effect on increasing keeping quality although the sugar can sometimes prevent the stems from splitting open. The flowers can be kept for up to two weeks.

Working on a good tuber after flowering

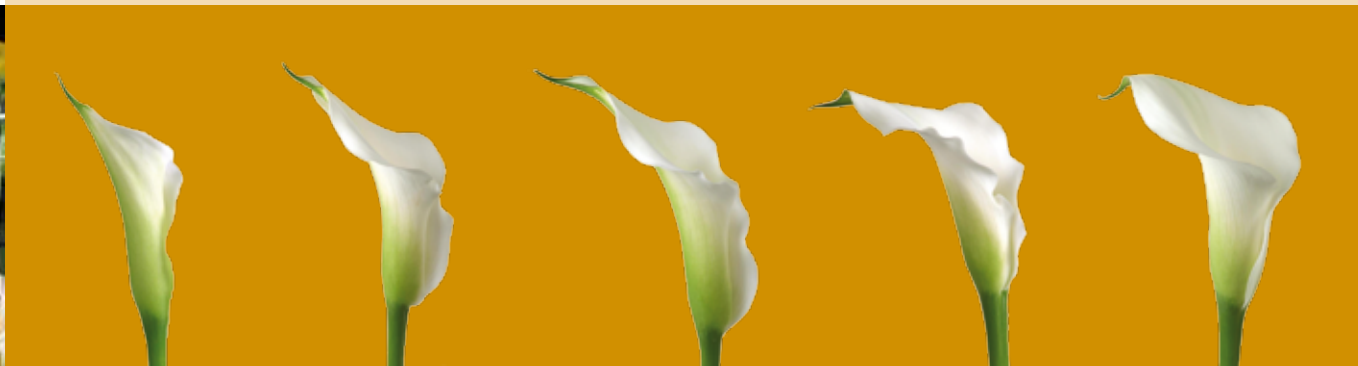
Working on good tuber development

Using the tubers for production following flowering can only be done with tubers planted in the spring. After flowering, continue to water and side dress moderately for around 2 to 3 months. Maintain a greenhouse temperature of 17-18°C. Once the crop starts to turn yellow and shows signs of dying back, watering must be stopped. Once the aerial parts of the crop have senesced, the tubers can be lifted. Trim away any leaf remnants to leave only a few centimetres above the tuber. Lift the tubers carefully to prevent mechanical damage that could result in chalking during storage. Dry the Calla tubers thoroughly after lifting.

STORAGE	DRYING	PREPARATION	TOTAL STORAGE TIME
Short-term storage	2 weeks at 17-23°C	2.5 months at 17-20°C	3-4 months
Medium-term storage	2 weeks at 17-23°C	1 month at 17°C + 13°C	4-6 months
Long-term storage	2 weeks at 17-23°C	1 month at 17°C + 9°C	4-8 months







Storage and preparation

If the tubers are to be sold dry or used for production for another year, the schedule below must be followed. Dry the tubers thoroughly after lifting and store them under dry conditions with proper air circulation. Before planting, activate the tubers by storing them for 2 to 4 weeks at 17-20°C at an RH of 80-85%. During this warm storage, the shoots will emerge; it also helps the tuber to start growing faster once planted.



Proper hygiene during production prevents problems later

This chart lists the most important diseases (and pests) and the methods to control them. Erwinia is one of the most important and commonly occurring diseases. Preventing stress and using proper hygiene largely reduce the risks of infections.

CAUSE	SYMPTOMS		PREVENTION/CONTROL
Erwinia (bacteria)		Affected leaves and stems turn dark green, display rotten spots, become slimy and eventually fall over. The tubers will also begin to rot and become malodorous.	Plant undamaged bulbs and prevent stress during growth. Plant in fresh soil or potting soil that is free of pathogens. Prevent mechanical damage to the crop and tubers as well as high temperatures combined with a high RH. Do not provide too much nitrogen when fertilising; prevent the growth of too much foliage.
Rhizoctonia (soil-borne fungus)		This fungus damages the shoot at the point at which it emerges from the soil and exhibits as spots that look eaten away.	Use fresh soil or potting soil that is free of pathogens. Soil suspected of being infected should be treated with a fungicide.
Botrytis (fungus)		Spots on leaves and flowers. A Botrytis infection on the leaves is almost always limited to a small spot and will not cause any problems.	Keep the crop dry to keep the fungus from germinating. If growing outside, use a crop spray containing a fungicide during flowering.
Pythium (soil-borne fungus)		This fungus causes root rot that keeps the plant from absorbing water properly.	Use fresh soil or potting soil that is free of pathogens. Soil suspected of being infected should be treated with a fungicide.
Penicillium (fungus)		This blue-green fungus grows on and sometimes in the tuber during storage. Infection grows particularly on places where the tuber has suffered mechanically damage and occurs under moist conditions. Infected tuber tissue is grey or brown.	Store tubers under dry conditions and prevent mechanical damage. Provide sufficient air circulation to prevent the microclimate surrounding the tubers from developing a high RH.
Thrips and aphids (insects)		Thrips cause elongated spots or strips on the flowers; aphids leave round green spots. Both these pests can also transfer viruses.	Prevent weeds during cultivation; control weeds outside the greenhouse as well. If thrips or aphids are identified, spray immediately before flowering with an insecticide.



GROWING ZANTEDESCHIA FOR CUT FLOWER PRODUCTION

PRACTICAL TIPS FOR

- ▶ CHOOSING THE RIGHT PLANTING MATERIAL FOR PRODUCTION
- ▶ GETTING PRODUCTION OFF TO A GOOD START
- ▶ PRODUCING FLOWERS OF HIGH QUALITY
- ▶ KEEPING THE CROP HEALTHY





Goal-oriented scheduling and planting

A beautiful cut flower and pot plant

The coloured Zantedeschia (also known as the Calla) can be used for cut flower production, pot plant production and for planting in gardens. After a growth period of 6 to 8 months, the tubers are formed, the aerial parts of the plant die back and the tubers enter a dormant period lasting at least 3 months. Once dormancy is broken, the tubers can be replanted and the growth cycle will repeat itself.

Plant immediately

The tubers have been treated by the time they are delivered and can be planted immediately. The earliest planting date for tubers grown in the Netherlands is mid-January. Forcing during the darkest period of the year is not really feasible yet. Outside, the crop starts flowering there on 1 July and continues until 1 October. In subtropical climates, it is possible to realise year-round flowering by combining greenhouse and outdoor production under shade cloths. In both climate regions, and depending on the cultivars being forced, shading to cut light intensity by 30% will be needed during warm periods to enhance stretching. The

Table 1. Planting periods with accompanying flowering periods

PRODUCTION LOCATION	PLANTING PERIOD	FLOWERING PERIOD
Greenhouse	mid-January - February	April - May
	March - April	June - July
	May - June	July - August
	July - early August	September - October - November
Outdoors	March - April	June - July
	May	July - August
	June	August - September

best way to distribute flowering over time is to plant at various times. One of the factors in the length of the flowering period is the number of flowers produced by the crop. A profusely flowering crop will be in flower for a longer time than one with fewer flowers.

Time spent in production depends on planting date

The period from planting to flowering depends on the time of year, how long the tubers were stored, the choice between greenhouse and outdoor production, and the cultivars being used. When planting in the greenhouse in spring, the time from planting to the start of flowering is 75-110 days. This time spent in production is fairly long because growth takes place during a cool period with little light, and the tubers have been in storage for a short period of time. When tubers are planted outdoors at the end of the spring or early summer, production takes 55-70 days. In this case, production takes less time due to more sunlight and higher temperatures. In addition, the tubers were stored longer. During the autumn, the crop will take 60-90 days to start flowering. The crop will grow quickly at first due to higher temperatures and plenty of light, but development will slow down toward the flowering period due to decreasing amounts of light and

lower temperatures. When tubers have been stored longer than 6 months, their development is somewhat slowed.



Tuber size, cultivar and dipping tubers in GA₃ determine number of flowers

The tubers

Treating the tubers on site after they arrive depends on the agreements made with the supplier and how long it will be before the tubers are to be planted.

Upon receipt, inspect the tubers for size, mechanical damage, chalking, Penicillium and softness caused by Erwinia. Remove any chalked and soft tubers to keep them from infecting others. If tubers are infected by the Penicillium fungus, they will have to inspected to see if the fungus is simply on the outside of them or has also turned the inside of the tuber itself grey or brown. If a tuber is cut open and is no longer white, it will have to be discarded. If the fungus is only on the outside, the tuber can be used if stored under dry conditions with proper air circulation *and* if it is planted fairly soon.

If the tubers still display scarcely if any shoot development, it would be advisable to maintain them at 17-22°C for another 2 to 4 weeks, preferably at an RH of 80-85%, to start activating them.

Each main shoot can produce two flower stems. The number of main shoots per tuber depends on the bulb size, cultivar and growing season. At the same tuber size, a small-flowering cultivar will produce more flowering shoots than a large-

flowering cultivar. In general, flower production per m² is lower when the cultivar being grown produces large flowers and the crop is tall. For flower production during the autumn, the largest tubers are preferred in order to obtain sufficient flowering.

Dipping for more flowering

More flowers are obtained by dipping the tubers in a solution of gibberellic acid (GA₃) for 15 minutes before planting. The tubers are usually dipped twice: once, during the last two to three weeks before planting, in a solution of 1 tablet to 11 litres of water, and a second time, immediately before planting, in a solution of 1 tablet to 7 litres of water.

Do not use the dipping solution any longer than three days. After a long storage period, the tubers will produce fewer flowers, so it would be advisable to use a somewhat higher concentration for these. Just like an excessively long storage, a dip in a higher concentration of GA₃ will increase the number of flowers but will also increase the risk of misshapen flowers. It would be wise to treat the tubers for fungi such as Penicillium at the same time. To do so, add the fungicides to the dip according to the instructions.



Plant only in suitable soil; otherwise, use boxes

Air-permeable soil for best growth

The tubers can be grown in practically all types of soil, but the important factors are an air-permeable structure and the capability to hold sufficient moisture. Too much moisture is not good and will require a good drainage system. To plant in a heavy clay soil, it would be preferable to plant on ridges or in raised beds to prevent exposure to too much moisture. This crop prefers a low EC (< 1.5) and a pH of 5-7. The soil must be free of pathogens, particularly Pythium and Rhizoctonia solani fungi. Previous to planting, and preferably as based on a soil sample taken beforehand, a basic dressing can be applied. If the soil has been used more often for Calla, it would be advisable to steam or disinfect the soil before the new production period in order to prevent possible problems associated with diseases.

With less suitable soil, force in boxes

If the soil is less suitable for Calla production (i.e. very heavy, poor drainage or pathogens in the soil) the tubers could also be forced in boxes. Production in boxes has another benefit: if conditions are warm once the tubers are planted,

they could root at 12-16°C in a cooler room. Once rooted, the boxes could be housed. The medium preferred for this would be an air-permeable peat mixture. If the subsoil contains pathogens, the containers will have to be placed so that they are not in contact with the subsoil. For planting, the boxes are filled 2/3 of the way with soil and the tubers are placed in an upright position on the soil. Afterward, the box is filled the rest of the way with soil. A sufficient amount of soil has to be put on top of the tubers because the roots emerge from the top of the tuber. Because the quantity of soil available to each tuber is less in a box than it would be otherwise, careful watering to keep the moisture levels uniform throughout the substrate is even more important. To achieve good results, it is particularly important to water evenly. The fertilising procedure and greenhouse climate for box forcing are identical to those used when planting directly in the soil. If the tubers are to be kept for another production period, watering should be continued for another month after harvesting the flowers. At that time, watering should be stopped to allow the foliage to die back.



Plant carefully for a good start

Plant tubers in an upright position and cover with enough substrate

The tubers have to be planted deeply enough because the roots emerge on the top of the tuber before growing downward. Since the upper centimetres of the soil are subject to wide fluctuations in moisture levels and temperature, the roots of tubers not planted deeply enough can be harmed by these fluctuations and result in culls. The planting depth depends on the tuber size and ranges from 5 cm for small tubers to 9 cm of soil on top of the tuber for the largest tuber sizes. It is important to plant the tubers with the growing point at the top. Planting the tubers on their sides or upside-down results in an uneven emergence, an uneven crop and more chance of culls.

Do not plant too many tubers per m²

Planting density depends on bulb size, cultivar and planting date. Do not plant too closely together as this results in less light reaching the crop, and, thus, fewer flowers. The risk of disease also increases because the crop cannot dry out as quickly. Plant taller cultivars somewhat farther apart because of their leaf mass. Maintain wide pathways to prevent mechanical damage to the crop during harvest. Plant the bulbs so as to make the most efficient use of the space. In the greenhouse, the use of crop support netting is recommended, particularly if flowering is scheduled for spring and autumn.

Positive effects from proper watering

Plant in uniformly moist soil. After planting, water so that the soil makes good contact with the tubers. This encourages



Table 2. Average planting densities per tuber size.

TUBER SIZE IN CM	NUMBER OF TUBERS / NET M ²
14 - 16	large to small-flowering cultivars*)
16 - 18	from 21 to 23
18 - 20	from 16 to 18
20 +	from 13 to 14
	from 12 to 13

Planting density also depends on cultivar and planting date
*) planting density for large-flowering cultivars is always on the lower side

quick rooting and a good start. It is better to provide water in small quantities several times than a large quantity all at once. Until the first leaves unfold, irrigation can be carried out by means of a sprinkler circuit. Afterward, watering from under the crop by means of tubes and drip irrigation is preferable in order to keep the crop dry and thus prevent culls. The crop requires little water from the first post-planting watering until the first leaves open. At that time, start gradually increasing the quantity of water given, depending on the capillary action of the soil. Regularly check root development and the moisture of the soil. It is better to water the crop in the morning so that it will be dry by that night. This also makes harvesting the flowers easier. A good irrigation system that distributes the water evenly is a necessity. Leakage following irrigation must be prevented due to the risk of Erwinia.

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