

Forcing Guide / Narcissus

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1. Methods of cultivation

Introduction: The name

The name 'narcissus' is derived from the Greek word 'narkaein', meaning paralysed or numbed. Narcissus was a beautiful, proud young man in Greek mythology. Too proud to return the love of women, the envy of those scorned led to his downfall. While out hunting one day, he stopped to refresh himself at a spring. Seeing his image reflected in the water, he fell in love with it and pined away for his unattainable love, until there was nothing left but a beautiful narcissus. The narcissi like the Hippeastrum and Snowdrop are members of the family of Amaryllis, also known as Amaryllidaceae.

Introduction: The origin

The narcissus genus comprises some 30 known species. The present narcissus cultivars arise from species (including *N. poeticus* and *N. pseudonarcissus*) native to the area stretching from central Europe to North Africa, mainly in the western Mediterranean (Spain, Portugal).

Introduction: Cold requirement

Like most other bulbous plants, narcissi, with the exception of a number of Tazetta narcissi, require a cold period. In narcissi it ensures rapid growth and flowering. Unlike tulips, where this period ensures a long stem.

A temperature of 9°C provides sufficient cold where as a cold period of 5 to 2°C will produce shorter crops.

There are two methods of production of forced narcissi: cultivation in trays or cultivation in the border soil of a static or mobile greenhouse. Each method of cultivation requires one or more different temperature treatments.

Introduction: Flower development

Since the narcissus flower is nearly fully developed before the bulbs are lifted, it cannot be greatly influenced by means of temperature treatment after lifting. However, by lifting the bulbs earlier and giving them a high temperature treatment, flowering may be advanced to November. For the production of narcissi flowers around Christmas and in January the bulbs are given a heat treatment. This treatment will advance flowering, will shorten the period in the greenhouse and ensure even crop development. Before the bulbs are cooled or planted they must be stored at 17°C for a minimum of two weeks. This temperature does not only ensure more rapid flowering, but also better crop development and flower quality.

Utilization

Narcissi are marketed as cut flowers or as potted narcissi. Both can be brought into flower in the greenhouse either in trays or in pots. The border soil of the greenhouse is only used for planting and forcing cut flower narcissi.

Forcing in trays: 9°C (pre-cooled) and un-cooled narcissi

With this treatment the narcissi bulbs are planted in trays which are then put in the rooting room or on a standing ground outside. The bulbs are either given the entire cold period in the rooting room, or outside on the standing ground. Narcissi forced in this manner are called 'un-cooled narcissi'. It is also possible to give dry bulbs part of the cold period (9°C narcissi) before they are planted in trays after which they are given the remaining cold period. These are called 9°C (pre-cooled) narcissi.

Forcing in the border soil of the greenhouse: 9°C

These bulbs receive the required cold period either in full or in part naturally in the border soil of the greenhouse. If dry bulbs are to receive part of the required cold treatment, this should take place at 9°C in the cold room (9°C narcissi).

2. Greenhouse, forcing trays and rooting media

Greenhouse

Tray-forcing takes place in the greenhouse, whereas forcing in the border soil is done in permanent or mobile greenhouses. Since narcissi are not very light-sensitive, the greenhouse does not need to meet specific light requirements. For the construction and the layout of greenhouses the same criteria apply as for tulips (see Tulip).

Forcing trays

As narcissi are more sensitive to moisture than tulips, the forcing trays need to meet certain requirements. Ideally the roots must remain inside the trays to prevent desiccation and damage. Damage to the roots leads to checked growth and impaired quality. Therefore, do not use flat, open trays. Not only the type of forcing tray, but also the depth of the soil layer underneath the bulbs is important in preventing desiccation. A soil layer of 8-10 cm underneath the bulbs is essential for the development of a sound root system. Moreover, it serves as a moisture buffer. In selecting forcing trays, bear in mind certain criteria: many trays are too deep and wide, and have protruding supports that get in the way when planting and harvesting.

In practice, tulip export trays are normally used. These 60 x 40 cm plastic trays with a height of 18 cm and an inside depth of at least 8.5 cm allow for the addition of sufficient substrate (e.g. planting soil). (see Tulip, Forcing trays).

Stacking

After planting, narcissi need height to develop. Always leave a gap of at least 10 cm between the nose of the planted bulb and the tray stacked above it.

If the shoots touch the tray above, the crop will grow crookedly. Lowering the greenhouse temperature to below 7°C to retard shoot development at the start of the season or before the bulbs have received the necessary cold period may lead to shorter growth in the greenhouses. However, if the bulbs have already received the entire cold period, the temperature may be dropped to 7-5 and even 2°C without problem later in the season. If the bulbs still tend to grow crookedly, the following measures can be taken:

- lift the trays by adding supports
- stack the trays crosswise
- place an upturned tray on all trays.

Rooting media and greenhouse soil

For information about substrate mixtures and greenhouse border soil, please refer to the Section on tulips (Planting soil and Soil requirements).

Unlike tulips, narcissi are especially susceptible to drying out, so it is not advisable to mix too much sand into the rooting medium. Sand does not retain moisture well, which means the soil and crop may dry out too quickly.

3. Choice and receipt of bulbs

Cultivar requirements

The cultivars used for forcing must meet the following requirements:

- they must produce flowers with sufficient stem length within an acceptable time
- the flowers must be large and sturdy and top the leaves by a few centimeters
- the crop should not be weak
- the collars must tightly grip the leaves and flower stem
- the flower production per kg bulbs must be sufficiently high
- the harvested product must have good keeping quality.

Bulb size

Apart from offsets and bulb sizes below 10 cm are generally acceptable for forcing, but the optimum size range will very much depend on cultivar.

Bear the following in mind when choosing the bulb size:

- The bulb size is particularly important for November and December flowering as large bulbs has far better flower yield and better quality than small bulbs. Flower blast may occur in offsets and small round bulbs. Saleable sizes are therefore preferred for flowering during these months
- Round bulbs size 15-16 are suitable for Christmas flowering. Smaller round bulbs can be used later in the season. Due to the larger number of flowers per kg bulbs, a denser crop develops which in turn increases the risk of a weak crop.

Receipt of the bulbs

Plant the narcissi bulbs as soon as they arrive. However, if storage is necessary, place the bulbs in open trays at 15-17°C (un-cooled narcissi) or at 9°C (cooled narcissi) in a well-ventilated room. The required supply of fresh air per 100 liter bulbs is 6m³/h at 17°C and 0m³/h at 9°C. Do not allow the relative humidity to exceed 75% for these two storage temperatures or premature rooting may occur. Higher temperatures inhibits growth and results in shorter crops. During storage at 9°C, humidity levels can rise to 95% or more. In combination with a poor air circulation this can result in premature rooting.

This problem can be avoided by increasing air circulation and if needed lowering the relative humidity. The humidity may be dropped by cooling the air to 7°C, which causes vapour to condense onto the evaporator, after which the temperature is raised to 9°C again.

4. Forcing 9°C (pre-cooled) and un-cooled narcissi in trays

Cooling: Introduction

The duration of the cold treatment (see Forcing in trays) depends on the cultivar and the time scheduled for housing the bulbs. The Manual Part 1 published by the International Bulb Flower Centre sets out the duration of the cold treatment per scheduled housing date for a range of cultivars.

The cold may be given to the bulbs either as a combined treatment (whereby the narcissi bulbs receive the cold treatment as dry bulbs (dry cooling) and the remainder after) or entirely after planting (wet cooling).

Cooling: Dry cooling

The dry cooling lasts as a part of the cold treatment 2 to 10 weeks. If the dry bulbs are cooled longer than 10 weeks, this may lead to problems due to excessive root development and/or poor rooting after planting. As a result the bulbs may be pulled out during harvesting. The first few batches must receive at least 9 weeks of dry cooling when soil temperatures on the standing ground are more than 9°C. If the bulbs are cooled for 9 weeks at 9°C, they may be planted in soil temperatures of up to 13°C. If these bulbs are planted after only 6 to 7 weeks of cooling, their development is halted in high soil temperatures. Flowering will take place at a later date. Under normal circumstances, the soil temperature will have dropped sufficiently by October. Whether a long dry cooling period of the bulbs is necessary depends on the following factors:

- Rooting time of the bulbs: rooting does not take place before mid-September.
- The costs involved in cooling; dry cooling requires less space than cooling bulbs planted in trays in the rooting room. It is therefore considerably cheaper.
- The time the cold period should be started (and the scheduled date for housing the trays in the greenhouse). If the trays are placed outside on a standing ground, make sure that the soil temperature has dropped to 9°C. If the soil temperature is higher, cooling may be given to dry bulbs only.

Cooling: Cooling after planting

Depending on the time the bulbs are housed, the bulbs receive the required cold treatment or only part of it after planting. In order to ensure sufficient rooting and proper shoot growth, the bulbs must be planted at least 5 weeks before housing.

Once they have received the cold period, the trays may be placed in the greenhouse.

Extending the cold phase has advantages and disadvantages.

If the cold phase is extended by one week, the greenhouse period is shortened by 3 days, which saves energy.

However, extending the cold period may cause other problems, including weak plants.

Cooling: Temperature

The optimum cold temperature for narcissi is 9°C. Higher temperatures inhibit the plant's development, thereby extending the cold phase. For each week that the cooling temperature exceeds the optimum temperature, the cold treatment must be extended by a week.

Temperatures below 9°C affect the plant length and the crop will remain shorter. Temperatures below 5°C inhibit the development of the plants in the greenhouse. To avoid having to extend the greenhouse period, use the above guidelines.

Planting time

Depending on the desired flowering period and suitability for a particular season, narcissi may be planted and placed in the rooting room until approx. mid-November. Since rooting starts from mid-September, it is not advisable to plant any earlier.

For flowering in March/April it is advisable to plant late and to lower the temperature until 2°C in time.

Excessive cooling increases the risk of elongated growth and crop flattening in the greenhouse. Do not plant after mid-November because of the risk of too low soil temperatures. Soil temperatures below 5°C delay root development. This may affect the quality and produce shorter crops.

Planting method

For forcing in trays, the bulbs must always be planted upright. Scattering the bulbs will give only moderate results. Pack the bulbs tightly together. Peat substrate mixtures are suitable for use as they retain water well. After planting, cover the bulbs with a 2-3 cm layer of sand to prevent the bulbs from pushing their way up. Use coarse-grain sand to avoid the soil from panning when it is watered.

Planting quantity and planting depth

The number of plants per kilogram depends on the bulb size used. For large bulbs a greater weight per m² surface area is planted than for smaller sizes. Assume a flower quantity of approx. 6 kg of bulbs per tray of 60 x 40 cm and a planting depth of 8 to 10 cm measured from the basal plate. A suitably thick layer of soil is important as it promotes the development of the root system and serves as a good water buffer.

Watering

After planting and covering with sand, the trays must be watered. Wet the soil thoroughly - narcissi are highly susceptible to water shortage. This is best done thoroughly straight after planting as it often proves difficult to provide water evenly throughout the rooting room. Watering by means of sprinkler installations mounted over the stacks carries a risk of soil settling and uneven water distribution.

The soil will settle especially when fine particle sand is used as a covering layer. As a result, the roots will rot, leading to a large number of rejects. Rejects will also occur when the soil in the trays dries out. Therefore, inspect the soil frequently for moisture content. When in doubt, water.

Rooting room: Temperature

For early forcing (until December) of bulbs planted in trays, maintain a temperature of 9°C throughout the cold period. From December, however, this temperature will drastically increase shoot development. In order to avoid the plants from growing crookedly, use trays that are deep enough or leave sufficient room between the stacked trays.

For later forcing (flowering from January), maintain a minimum temperature of 7°C. Only when there is a risk that the shoots could become too long the temperature should be dropped to 5°C. An extended period (4 weeks or more) at this low temperature will result in a shorter crop and a longer period in the greenhouse compared with bulbs stored outside on a standing ground.

Rooting room: Combination of tulips, narcissi and hyacinths

The following temperatures are recommended for tulips in the rooting room: 9°C until 20 October, 7°C until 10 November and 5°C until the shoot length begins to become extensive, followed by 2-0°C.

Narcissi intended for flowering in December receive a temperature of 9°C throughout the entire period in the rooting room. When the rooting room also contains planted tulips, the “Tulip treatment” (see above) may be used. Lower temperatures not only arrest shoot development, but also result in shorter stemmed narcissi and an extended period in the greenhouse. For narcissi intended for late forcing, do not allow the temperature in the rooting room to exceed 7°C for normal shoot development. However, since tulips require different temperatures for late forcing, the combination of tulips and narcissi in the rooting room is only possible for early forcing (until 1 December). From the beginning of December the temperatures for tulips and narcissi in the rooting room are not the same, unless low temperatures are compensated by a longer cold period.

Since narcissi and hyacinths require similar temperatures, they may be accommodated together in the rooting room until the end of January without any problem. However, from February the temperature recommended for hyacinths (5°C) leads to short plants and slow growth in narcissi. Here, too, the cold period needs to be extended to compensate for the lack of cold.

Rooting room: Humidity and relative humidity

Water the bulbs thoroughly immediately after planting. This should in principle suffice for the remainder of the time they spend in the rooting room. However, do check the moisture levels of the substrate frequently and water if necessary. The relative humidity in the rooting room must be between 90-95% and must be checked regularly in various locations in the room. If necessary, the humidity should be raised by wetting the floor in the room or by running the condensation water from the evaporator onto the soil. A lack of water in the rooting room leads to a weak crop in the greenhouse.

Rooting room: Ventilation and air circulation

While the planted bulbs are stored there is no need for regular ventilation. It suffices to open and close the door to the rooting room, for example when the crop is inspected and/or when a batch is brought in or taken out. The air must circulate freely to ensure an even temperature distribution. Prevent the substrate and roots from drying out.

Standing ground

Instead of a rooting room, the trayed up bulbs may also be stored on a standing ground. For more information, refer to Tulip, Standing ground.

This is recommended until mid-November after which it becomes difficult to maintain the right temperatures.

During frost, cover the trays on the standing ground with straw (in severe frost also with bubble foil) to prevent frost damage.

5. Forcing 9°C (pre-cooled) and un-cooled narcissi in the border soil of the greenhouse

Cooling: Introduction

Forcing in the border soil of the greenhouse or mobile greenhouse entails treating the dry bulbs with part of the required cold in the cold room (9°C pre-cooled narcissi) after which the remainder of the cold period is given to the planted bulbs. Alternatively, the bulbs receive the entire cold period after planting. These narcissi are referred to as 'un-cooled narcissi'.

Once the narcissi have received the necessary cold, the temperature in the greenhouse may be raised.

Cooling: Temperature

For information about temperature control and duration during cooling see Cooling; Temperature. To achieve good rooting the soil temperature for narcissi planted outside and intended for the mobile greenhouse should be maintained for at least 4 weeks at 9°C. Keep this in mind especially for the last planting. Cover the soil to maintain the desired soil temperature for the required period.

Planting time

As soon as the soil temperature has dropped to 9°C, the narcissi may be planted in the border soil of the greenhouse or on mobile greenhouse sites.

Un-cooled bulbs may be planted until approx. mid-November, depending on the desired flowering time and suitability for the forcing period. Later plantings are not recommended in view of the increased risk of low soil temperatures.

Planting methods

Narcissus bulbs which are forced in the border soil of the greenhouse or in a mobile greenhouse, are often scattered. In comparison, planting the bulbs upright has the following advantages:

- the crop develops more uniformly, which results in a shorter period in the greenhouse and lower energy consumption per batch
- the bulbs yield 10% to 20% more flowers
- fewer bulbs are pulled out during harvesting, drastically simplifying the harvest process
- if the bulbs are covered with a thin layer of soil only (see Planting depth), the flowers may be harvested with a knife
- the collar that keeps the leaves and flower together is often harvested together with the flowers to enhance their appearance
- the quality of the narcissi blooms is better, as the flowers are of equal length and produce fewer crooked stems.

A drawback, however, is the labour costs involved in planting the bulbs upright, although this is easily compensated for by the higher quality and shorter period in the greenhouse.

Planting quantity and depth

The bulbs are planted tightly together. The planting density expressed in kilograms depends on the bulb size used. Planting quantities of larger bulbs are greater in kilograms per m² than smaller sizes. In the greenhouse appr. 25 kg bulbs are planted per net square meter. Plant at a depth of 10-15 cm, measured from the basal plate. However applying 1-2 cm soil over the nose covered with a thick layer of straw is becoming increasingly popular. Although these narcissi are easy to harvest with clean stems and well-developed collars, they are very sensitive to frost damage.

Cover

After planting the bulbs, cover the soil in the field (mobile greenhouse) to prevent damage from frost. Straw is most commonly used for this purpose. In a mild autumn the cover also ensures a slight fall in the soil temperature. This may be particularly important in October. The amount of covering material needed depends on the planting depth. For a planting depth of 10-15 cm measured from the basal plate, 3 to 4 kg straw per m² will suffice. However, use more straw if the bulbs are covered with only a few centimeters of sand.

When a prolonged period of frost or severe frost is expected, the bulbs must be covered with plastic sheeting. Remember to do this before the soil has frozen to be able to attach the sheeting. The sheeting prevents frost damage caused particularly by dry winds during periods of severe frost.

Moisture supply

The bulbs need an adequate supply of moisture to root properly. Bulbs intended for early forcing in particular only have a few weeks to root. The amount of water needed depends on the planting method and the planting depth of the bulbs. By irrigating the soil the temperature may be lowered, especially in October.

6. Procedures for forcing in trays and cultivation in the border soil of the greenhouse

Crop advancement

By holding trays starting from the second batch underneath the benches until the flowers of the first batch have been harvested, one or two additional batches may be harvested each season. Due to the labour-intensive work involved, however, this method is still not very common. Another option to reduce the period in the greenhouse is by forwarding the bulbs in a slightly heated room. The trays may be stacked, provided even temperature distribution is guaranteed. Especially between the lowermost and the top tray in the stack big differences in temperature may occur, which will then lead to uneven growth in the greenhouse. The period the trays may be held without any additional light (under the bench or in a stack) depends on the shoot length when the trays are brought in). The longer the shoot, the shorter the forwarding period. If the shoots become too long, there is an increased danger that at harvest stems are weakened. Remember that it will take at least two weeks for the plants to flower in the greenhouse.

Housing

After the cold period has been completed the trays may be brought in or the (mobile) greenhouse may be heated.

The duration of the cold period depends on the cultivar and the time at which it is brought in or (for the cultivation in the border soil of the greenhouse) when the greenhouse is heated. The Manual, Part 1, sets out the cold requirement in weeks for a wide range of narcissus cultivars. Minor frost damage may occur when the plants are transferred from the standing ground to the greenhouse during a period of frost. Therefore, be careful removing the straw or plastic sheeting before bringing in the trays, or remove it in the greenhouse where possible. During the transportation of the trays into the greenhouse, the shoots may freeze (dry out). To minimize this risk, transfer the trays in the afternoon when there is little wind. Cover the shoots with plastic sheeting in the greenhouse to allow them to adapt gradually to the higher temperatures and to reduce the risk of desiccation.

Watering

Bulb flowers, and especially narcissi, are sensitive to water shortage, which will lead to shorter plants and may even cause flower blast. Tray forcing requires more frequent watering than forcing in the border soil of the greenhouse.

Since the root system of the earliest housed narcissi is usually poorly developed, they are more susceptible to water shortage than batches that are planted later. Frequently check the moisture of the substrate in the trays. Pay extra attention to the sides of the tray since these tend to dry out quickly. For further information regarding watering systems, refer to Tulips, Irrigation installation. Crops grown in the border soil of the greenhouse or in mobile greenhouses do not require frequent watering. When the soil underneath the bulbs can be easily shaped into a ball, the soil is moist enough. Always provide high humidity levels in the greenhouse. Relative humidity may be increased by regularly applying small amounts of water.

Greenhouse environment: Temperature

The temperature in the greenhouse should not exceed 18°C. Instead of accelerating flowering, higher temperatures will affect the quality and keeping quality of the flowers and increase the risk of flower blast.

For double and red-cupped narcissi a maximum greenhouse temperature of 16°C is recommended. Although this temperature will increase the time spent in the greenhouse, it does improve the intensity of the color of the cup and reduces the risk of flower blast.

When the cold period is exceeded by more than two weeks, it is advisable to substantially lower the greenhouse temperature, even by refraining from heating the greenhouse. By extending the cooling, the plants will grow too quickly. As a result, they become weak and there is an increased risk of topple.

Greenhouse environment: Humidity

Narcissi require a high relative humidity. If it is too low, the crop quality will be impaired. It is advisable to maintain a constant relative humidity of more than 90%. The RH may be increased by providing small amounts of water or by regularly wetting the path between the benches.

Ensure that the greenhouse is insulated as this will facilitate humidity control and save energy. Suitable insulation materials are plastic sheeting and bubble plastic. The risk of inadequate humidity levels is greatest during periods of frost and when hot-air heaters are used.

It must be possible to ventilate the greenhouse in the event of strong isolation. Quickly rising temperatures may lead to bud blast.

Greenhouse environment: Light

There is still no agreement as to the minimum light requirements of narcissi. However, studies have shown that the amount of light affects the plants and the more light is given, the sturdier the plants.

Period in the greenhouse

The time spent in the greenhouse depends on the temperature treatment and the flowering time. The Manual sets out the greenhouse period for a number of narcissus cultivars forced at a temperature of 16-18°C.

Compared to forcing in trays, the forcing period in the (mobile) greenhouse is extended by appr. 11 days in December, 4 in January, 3 in February and 2 in March. After the mobile greenhouse has been rolled over the plants, it will take a relatively long time before the soil temperature has come to the right level. The temperature in the greenhouse or mobile greenhouse is usually lowered to achieve a spreading of the harvesting time.

Harvesting stage

The right harvest stage is of decisive importance as it determines the quality of the product. The maturity stage of narcissus flowers is categorized as follows:

Stage 1: immature buds with empty tip (“pin”)

Stage 2: the spathe (the bract enveloping the bud) is filled (“mature bud”)

Stage 3: the spathe is split, the colour of the bud is clearly visible (“split bud”)

Stage 4: the flower is half opened (“over mature”)

The flowers must be harvested at the right stage to ensure the customer receives a quality product. Until mid-January the narcissi are harvested in stage 3 (split buds). From mid-January the narcissi may be harvested in Stage 2/3 (mature, possibly slightly open buds). Always harvest double-flowered narcissi when the bud has opened.

Harvest, storage and preparation for sale

The flower stem and leaves are harvested together. Narcissi forced in trays are cut off just above the bulb. In mobile greenhouses Narcissi flowers are snapped off the bulb, planting depth permitting. Although Narcissi that are planted upright at not too great a depth are often cut with knives. It is important that the collar, which holds the flowers and leaves together is included. Narcissi flowers marketed with their leaves have a greater commercial value. To ensure that the collars grow to their full length, the bulbs must complete their entire cold period.

The flowers must be removed from the greenhouse immediately and placed in a cold room, preferably in cold water at 1-2°C and at a high relative humidity (90%). The high relative humidity ensures that the spathes remain supple, preventing problems later in the vase. When the product temperature has fallen to approx. 2°C the flowers can be bunched (10 flowers per bunch). Bunches are then transferred to the cold room where they are stood upright either dry or in water, or are transported in a refrigerated unit. The flowers should never be stored for more than three days on the premises.

Clean the flower containers thoroughly after use as narcissi release a slimy substance that affects the keeping quality of other flowers.

7. Other narcissus

Cut-flower cultivation of 'Paper White': Introduction

From a botanical point of view, "Paper White" is not the correct name for these white Tazetta narcissi. They are the cultivars Ziva, Sheleg and Galilee.

Cut-flower cultivation of 'Paper White': Temperature

The optimum storage temperature for these narcissi is 25°C. After the formation of the inflorescence has been completed (late October), the bulbs are stored at a temperature of 17°C until they are planted. This temperature ensures a shorter period in the greenhouse and a good balance between the stem and leaf length. The length of the storage period at 17°C depends on the planting time (Table).

During storage of the bulbs, especially at 17°C, provide adequate air circulation to prevent excessive root formation.

Cut-flower cultivation of 'Paper White': Planting

After the storage period at 17°C has been completed, the bulbs are ready for planting in trays or in the border soil of the greenhouse. The table shows the estimated number of stems and the planting density according to bulb size. With regard to flowering quality, use the largest size bulbs.

Cover the trays with a thin layer of coarse-particle sand to prevent the bulbs from pushing up through the soil, and water the bulbs.

Cut-flower cultivation of 'Paper White'

Tazetta narcissi do not require a cold period to advance their flowering.

After planting, the trays are housed directly into the greenhouse. When planted in the border soil of the greenhouse, heat is directly needed.

The temperature in the greenhouse must be maintained at 16-18°C. Also provide a high relative humidity (formation of spathes). Fluctuations in the temperature may cause a form of flower blast in the inflorescence. Lower temperatures stimulate leaf growth which will obscure the flowers. This may be prevented by raising the greenhouse temperature in advance.

The number of days spent in the greenhouse depends on the cultivars and the cultivation period and is between 33 and 10 days from mid-November until April.

Harvest when 1 to 3 flowers have opened per inflorescence. Keeping quality is 7 to 10 days.

Pot narcissi: Introduction

Since the cultivation of narcissi in pots is very similar to tray forcing, we shall only discuss the differences.

Pot narcissi: Planting material

Ideally pot plants should have 10 to 15 flower stems per pot. The number of flower stems depends on the bulb size and the cultivar. Bulbs with more than one nose produce more flowers than round bulbs. Tazetta are generally more effective than single-flowered narcissi. The optimum length of pot narcissi is 25-30 cm.

Pot narcissi: Storage

If possible, narcissi bulbs must be planted upon receipt. If this is not possible, cooled bulbs are stored at 5°C and un-cooled bulbs at 20-17°C.

Pot narcissi: Cooling

The storage period is followed by the cold period. Since the cold period scarcely affects stem length, the recommended cold period for narcissi flowers may be shortened by 1 to 2 weeks for production in pots. In addition to the cold period for cut-flowers, the Manual Part 1 also gives details about the most suitable cultivars for growing in pots. The table is based on an average cold requirement for pot narcissi of 14 weeks. It sets out the number of weeks cold and the cooling temperature for both dry and planted bulbs, according to the flowering period.

If rooting at 2°C is not good enough, the temperature can be raised to 5°C for 1 to 3 weeks. Although the cooling of planted bulbs will yield a slightly taller crop, it is recommended for cultivars susceptible to Botrytis and penicillium. To ensure good and uniform development of the roots, cultivars including Tête à Tête and Jack Snipe receive their 14-week cold period at 5°C after planting.

Planted bulbs are best stored in the rooting room where the temperature can be controlled effortlessly.

Pot narcissi: Planting procedures

Treat the bulbs with fungicide before planting (see 8.2) to prevent losses during cultivation. Cultivars susceptible to Botrytis, such as Tête à Tête, are best planted in substrate mixtures with high percentage of black peat and/or sand. The bulbs are lightly pressed into the soil. Plant an uneven number of bulbs in the pots, e.g. 3, 12-14 cm round bulbs in a pot with a diameter of 9 cm. In order to prevent the bulbs from pushing up through the soil, in the first 4 weeks cover in a 3-4 cm layer of coarse-particle sand or foam.

Water the bulbs carefully after planting. Prevent over watering; in Tête à Tête excessively moist soil may lead to an infection by Pythium. 60 liters of water per m³ substrate suffices.

Pot narcissi: Period in the greenhouse

Transfer the pots to the greenhouse after the bulbs have received the entire cold period. If necessary, the cultivar Tête à Tête may be stored at 0.5 to 2°C for another 2 to 3 weeks for retarding before transferring the pots to the greenhouse. This does not impair the quality. The same method may also be applied after the pots have been stored in the greenhouse for one week.

The amount of water must be carefully applied to prevent quality reduction.

After 1 to 2 weeks in the greenhouse at a temperature of 15-18°C, the pots are ready to be marketed. They will have developed a few leaves, which will enhance their appearance at point of sale. A clean pot supplied with a label with instructions and a note that the pot may be placed in the garden after flowering, will also help to boost sales.

8. Crop protection, diseases and disorders

General soil treatment

Crop rotation is a tried and tested method to prevent diseases on the standing ground and it eliminates the need for a general soil treatment. However, soil treatment is called for if the soil on the standing ground is reused for filling the pots or for covering the bulbs. The soil treatment applied to tulip and hyacinth bulbs is also suitable for the production of narcissi. This is described in greater detail in General soil treatment in the tulip section.

Bulb treatment

The various treatments are discussed in the Section on tulips, Bulb treatment. To prevent the occurrence of fungal diseases, follow the cultivation measures described above. Information regarding bulb treatment in the event of fungal infection is available in the monthly Info bulletin published by the International Bulb Flower Centre. Your local information service or the bulb supplier will also be able to help you with advice. However, fungicide treatment of the bulb is not necessary if the narcissi are planted at 9°C and the shoot is not restricted during the cold phase. Exceptions are cultivars that are susceptible to *Botrytis cinerea*, such as Barret Browning, Flower Record, Gold Medal, Tahiti and Prof. Einstein and miniature narcissi for pot-plant cultivation, such as Tête à Tête, Jack Snipe and others that are susceptible to *Botrytis/Penicillium*.

Fungal diseases: Fusarium

The infection starts from the basal plate, usually in the root wall. The disease then spreads across the entire plate to the scales. The inside of the scales are not usually affected as quickly as the outside.

Infected tissue turns dark grey to dark brown. Between the scales and underneath the brown, skin-like scales, white or bright pink fungal tissue develops, often covered with a layer of 'powder' formed by numerous spores. Bulbs that are visibly affected by the fungus do not emerge or develop short, often crooked, shoots, that die quickly. Bulbs that are not seriously affected produce shorter plants often with thin leaves that grow crookedly and that are a brighter green than the healthy plants.

Cause

Bulb rot is caused by the fungus *Fusarium oxysporum* Schlecht. f.sp.narcissi, which only infects narcissi. The fungus, which has no other host than narcissi, can survive for up to six years in the soil.

Control

- Plant the bulbs after delivery at soil temperatures below 14°C (preferably 9°C) (See Cooling) or store them briefly at the recommended temperature, humidity, air circulation and ventilation
- Remove all infected bulbs on planting
- If planting takes place at temperatures higher than 14°C, use a widely-spaced crop rotation on the standing ground and in the border soil of the greenhouse or mobile greenhouse.

Fungal diseases: Grey mould / Botrytis

When the bulbs are housed or emerge in trays, some leaf tips turn brown and may stick together. The infection also affects the shoot and/or the leaves at soil level. The shoot falls over and the leaves grow crooked and turn yellow (grey rot). The skin of the infected bulbs is darker brown than normal, and the discoloration also affects the bulb scales.

In serious attacks, shoot development is slow or non-existent. Sclerotia appear on the dark patches and later turn black. The basal plate occasionally turns brown and corklike, which impairs rooting of the bulb.

The bulbs may also be infected without the shoot showing these symptoms. In serious infections the bulb may rot completely (botrytis rot). In the pot production miniature cultivars such as Tête-à-Tête, Jack Snipe and Hawera are particularly at risk. Susceptible cultivars for cut-flower production include Barret Browning, Scarlet O'Hara and Prof. Einstein.

Cause

The infection of the leaves (grey mould) is caused by the fungus *Botrytis narcissicola*, while the bulb infection (Botrytis rot) is caused by the fungus *Botrytis cinerea*. All other symptoms may be caused by either of the fungi.

Control

- Plant the bulbs immediately upon arrival or store them with sufficient ventilation and air circulation
- Prevent damage to the bulbs
- Always disinfect all pot narcissi and susceptible cultivars for cut-flower production as well as suspected batches in accordance with the instructions. (see the Info Bulletin of the International Bulb Flower Centre)
- Use substrate mixtures with a large proportion of black peat and/or sand
- Lightly press the substrate upon planting, place the bulbs on top and cover with a thin layer of coarse-particle river sand
- Cool the bulbs only after planting.

Disorders: Flower blast

Flower blast is a disorder where buds do not fully open. The most common symptoms are desiccated buds (so-called 'flower blindness'), green petals, white leaf tips and insufficient opening of the flowers at the retailer.

Cause

The disorder may be caused by the use of small bulbs, an too early start of the cold period, too early housing in the greenhouse, too high greenhouse temperatures, water shortages or low humidity levels during the forcing period.

Control

- Maintain the recommended cold period
- Keep the temperatures down during forcing
- Always provide sufficient water and keep the humidity in the greenhouse high.

Disorders: Brown discoloration of the spathes

In this disorder the spathe turns brown and the flower emerges with difficulty. The disorder is usually coupled with irregular growth of the crop.

Cause

Discoloration of the spathes may be caused by early housing of the trays in the greenhouse and lack of moisture during forcing.

Prevention

- Maintain the recommended cold period and do not house the trays in too early
- Keep the humidity in the greenhouse at a sufficiently high level
- Store the flowers at a minimum relative humidity of 90%.

Disorders: Short collar

The length of the collar is an important factor in harvesting narcissi. Problems may arise in the rooting room with the length of the collars (leaf sheath). If it is too short, it cannot provide sufficient support to hold together the stem and leaves after harvesting. This slows down bunching and impairs the ornamental value.

Cause

The length of the leaf sheath varies according to the cultivar, although the longer the shoot at housing and the longer the collar. Important for the shoot length are the time of forcing, the duration of the cold phase and the cooling temperature.

Since crops stored in a rooting room are brought in with short shoots, especially during early forcing, short collars are to be expected.

Control

- Maintain the recommended cold period and the right temperature (9°C)
- Prevent damage to the collars upon harvesting.

Disorders: Flattened crops

Flattened crops are a regularly occurring problem in forced narcissi, which result in a greater number of losses, poorer quality and problems during harvesting.

Cause

The main reason crops go weak and 'fall' over is too rapid growth in the greenhouse as a result of excessive cooling and too high greenhouse temperatures. The rapid growth in the greenhouse results in a weak and ultimate flattened crop.

Most at risk are batches or cultivars that produce a large number of flowers. Other cultivars such as Dutch Master and Unsurpassable with only limited flower production, are less susceptible.

Control

- Choose the right cultivars for late harvest (longer cold period)
- Maintain the recommended cold period, adjust the planting time to the flowering period and store the bulbs until planting at 20°C
- Do not plant the bulbs too closely together, especially not during production in the border soil of the (mobile) greenhouse
- Maintain the recommended greenhouse temperatures

- If it is anticipated that the crop will flatten then lower the temperature and the relative humidity in the greenhouse and provide sufficient light in the greenhouse.

Disorders: Frost damage

Minor frost damage caused before the plants emerge retards growth and cause the plants to grow twisted. Many leaves turn yellow-green and are rough to the touch. Within the flower stems cavities may develop where the stems break easily. The basal plate is glassy and pale grey. Severely frost-damaged plants do not emerge.

Cause

Frost damage occurs when the bulbs are stored for some time at temperatures below -1°C. Minor damage occurs after two days at a temperature below -2°C and gradually becomes more serious the longer the bulbs are stored at this temperature. Lower than -5°C serious damage occurs even after a few hours.

Prevention

- Always plant the bulbs upright
- Prevent heat loss and the occurrence of dry soil on the standing ground and in the mobile greenhouse
- Place the trays level onto the ground. Make sure there is no gap

Cover the narcissi on the standing ground, those on mobile sites and the greenhouse border soil making sure to keep a stack of the greenhouse soil and always keep a stock of plastic or bubble sheeting ready in the border soil for this purpose.