Forcing Guide / The Hyacinth

International Flower Bulb Centre

1. Temperature treatment

Introduction

The hyacinth has it's origins in Asia Minor, and the current Dutch cultivars have descended from Hyacinthus orientalis, a blue species imported around the middle of the 16th century. A member of the Liliaceae family, the hyacinth over winters in the form of a scaled bulb. Applying temperature treatments to produce hyacinths in greenhouses was introduced at the beginning of this century.
Like the tulip and several other bulbous plants, the hyacinth does not produce a high quality flower nor sufficient stem length until the bulb is exposed to a period of low temperature.

Uses for the hyacinth: Introduction

The hyacinth is marketed in either pots or as a cut flower.

Uses for the hyacinth: Pot hyacinths

One or more bulbs are planted in a pot, and a temperature treatment is used to force the bulbs into flower. Pot hyacinths are usually marketed when the lowermost florets of the flower cluster begin to separate. If taken from the greenhouse before the plants reach this stage, the plants are called "sprouted hyacinths". Although various bulb sizes are used for pot production, the usual sizes are 17/18, 18/19 and 19+ (cm).

Uses for the hyacinth: Cut hyacinths

For production of cut flowers, the bulbs are planted in forcing boxes and, as above, forced into flower by use of a temperature treatment. Various bulb sizes can also be used for this type of production, but sizes 15/16, 16/17 and 17/18 (cm.) are preferred.

Temperature treatment: Introduction

The growth cycle of the hyacinth bulb encompasses distinctive periods - leaf formation, flower formation and stem elongation. Forcing is achieved by advancing the flower-formation period and then providing the most effective type of cold period. This is why hyacinth bulbs grown in Mediterranean countries are used to produce very early flowers. The leaf-formation period is accelerated by higher temperature during the bulb's cultivation stage, hereby starting the flower formation period earlier.
In contrast to other bulbous plants, early flower- formation in the hyacinth is achieved by providing specific temperatures. One way of achieving this is to increase the temperature of the soil in which the bulbs are grown ("Herald hyacinths"). Because of its expense, this method is very rarely used. More commonly, the bulbs are lifted early and then given a temperature treatment in an air-conditioned chamber to advance flower formation. The lifting date and temperature treatment are the factors which separate the two methods of production pot and cut flowers.

Temperature treatment: Prepared hyacinths

Bulbs are lifted around 20 June after which a specific sequence of temperatures is applied to advance flower formation. Depending on where the bulbs are grown, the cultivar and the lifting date, the flower is completely formed during the second half of August. In technical terms, this is described as having reached "Stage G". Since the hyacinth has a flower cluster, this stage is not reached until the last floret is differentiated. The stem elongation period can then proceed. Prepared hyacinth bulbs are used for producing pot plants intended to bloom until late December, and cut blooms until mid-January.

Temperature treatment: Unprepared hyacinths

Bulbs are lifted later (after 20 June) and receive a temperature which encourages optimal (less advanced) flower formation. During this treatment period, Stage G is reached, although this occurs much later than in prepared bulbs. The temperature is maintained until it is necessary to start the stem elongation period. This means that after Stage G is reached, a growth-retarding temperature is applied.
With unprepared bulbs, less importance is attached to when Stage G is reached. This is of less concern despite the fact that Stage G will sometimes not have been reached when the stem elongation period begins. Since the bulbs are less advanced, this causes no problems later in cultivation. Unprepared hyacinth bulbs are used as pot hyacinths for flowering after 1 January and for cut flowers after mid-January.

Intermediate temperature

For prepared bulbs, a temperature of 17ºC is maintained after Stage G is reached. This encourages the hyacinth to enter the stem elongation period. In spite of the fact that the flower-formation period is over, the intermediate temperature still has an effect on flower quality; at a temperature of 17ºC, this effect is definitely beneficial. An intermediate temperature lower than 17ºC is inadvisable due to a sharply increased risk of Penicillium and a somewhat negative effect on the quality of the forced hyacinths. The risk of green or desiccated florets at the top of the flower cluster increases, a problem which encourages the development of blind florets and bud rot.
For unprepared hyacinths, the intermediate temperature starts four weeks before planting, at which time stem elongation begins. If planted after 15 December, a temperature of 25ºC is maintained instead of 17ºC until planting; this is done to prevent root formation and subsequent Penicillium attack. The following cold period will however, have to be extended by 1-2 weeks.

2. Steps in planting pot hyacinths

General

Concerning the subject greenhouse, trays/containers and potting soil we refer to the section of the tulips.

Arrival

Prepared hyacinths should be planted immediately upon arrival. If the bulbs must be stored, they should be placed in open containers (trays) and stored in a ventilated room at 17-20ºC. The amount of ventilation can be calculated as follows:

- at 17ºC, 2 m3/hour/100 liters of bulbs;
- at 20ºC, 6-10 m3/hour/100 liters of bulbs.

Temperatures higher than those indicated have a delaying effect on the development of the flower. Temperatures under 17ºC cause a higher r.h. - an factor which leads to a much increased risk in Penicillium attack in parts of the bulb such as the emerging roots. This can then have a negative effect on the quality of the flowers.

Unprepared hyacinths should be stored as follows:

- at 23-25ºC, 6-10 m3/hour/100 litres of bulbs and 4 weeks prior to planting;
- at 17ºC, 2 m3/hour/100 litres of bulbs.

Planting time

When to plant hyacinth bulbs depends on several factors:

- Their preparation. The best time to box-up prepared bulbs is during the second half of September. Unprepared bulbs are planted from October.
- Storage during the cold period. If the bulbs are stored in a rooting room which is not air-conditioned or in an outdoor storage clamp, they cannot be planted until the ambient temperature has fallen to 13ºC or lower (optimal temperature: 9ºC). Higher temperatures cause poor rooting, an increased risk of Fusarium attack, and a slow down in growth. Storing bulbs at 13ºC for a few weeks immediately before planting is acceptable.
- Required flowering period. By counting back the number of weeks from the required flowering period, the right planting date can be calculated.
- The required cold period per cultivar and time of year
- Cultivar. Not every cultivar is suitable for every planting period. In addition to the duration of the flower development period and the length of the cold period, other factors include problems with plants becoming too tall and too limp in the greenhouse.

Planting method

Planting one or 3-5 bulbs per pot is preferred. The bottom of the pots has to have drainage holes. There are a number of soil types or mixtures with a pH of 6-7 that can serve as filler in the pots. To avoid skin irritation during handling bulbs at planting, the bulbs can be wetted by spraying them immediately before planting. Dipping them is highly inadvisable because of the risk for an Erwinia attack. When planting, fill the pots completely with soil and push the bulbs into the soil. One point to remember is that hyacinths always have the tendency to push their way upward out of the pot as a result of osmotic pressure. Bulbs planted later in the season tend to do this more than those planted first. To avoid this problem with bulbs in the rooting room, add a layer of coarse sand (min. 3 cm.) on top of the bulbs, or put a foam cover over them. Growers also place racks over the bulbs for this purpose. After three to four weeks the bulbs are sufficiently rooted, and these racks must be removed to avoid damaging the shoots. The racks can be reused for the next forcing.
Planting density depends on pot size, but the maximum is 200 bulbs per m^2. After planting, the pots should be fairly well watered but not to excess. An over-wet potting soil reduces the quality of the rooting environment. This increases the risk of a Pythium attack in the roots.

3. Rooting room and standing ground

Rooting room: Introduction

After potting up, the pots can be placed in a rooting room, leaving enough space for shoot growth.

Rooting room: Temperature

The ideal temperature for hyacinths is a constant temperature of 9ºC throughout the required cold period. This temperature should commerce immediately after the bulbs are planted. If, however, a rooting room without air-conditioning is used, a starting temperature of 10-13ºC is acceptable. After one to two weeks, however, the temperature must be dropped to 9ºC. If not, this lack of cold will have to be compensated for at the end of the cold period. Hyacinths are usually placed in the same rooting room as tulips. Table 1 indicates the optimal cold temperatures for the box forcing of tulips.

From 5 November onwards, the temperature is allowed to fall to 5ºC, which will delay the hyacinth's flowering period. On the other hand, keeping the prepared hyacinths at 7ºC until housing will delay the flowering date for the tulips. A compromise is needed.
Unprepared hyacinths can be placed in the rooting room with tulips only under certain conditions. If the hyacinths are planted after 15 October, they can share a rooting room with tulips only after having undergone a rooting period lasting at least 3-4 weeks at a temperature of more than 5ºC (optimum 9ºC). During the period in the rooting room, the temperature must not drop below 0°C. Additionally, the cold period as indicated for the various cultivars in the table below will have to be extended, depending on the degree of cold, for another 2-4 weeks.
If a rooting room is available for hyacinths alone, the temperatures indicated in Table 1 can be used.

When hyacinths remain in the rooting room longer than recommended, the temperature will eventually have to be lowered to prevent excessively vigorous shoot growth.
Ensure an even temperature distribution in the room simply by starting the evaporation circulators during cooling. During the initial cooling period, it may be necessary to have these circulators running continuously or to use ceiling circulators. Make regular temperature checks at various places within the rooting room, especially between the bulbs themselves. Use a thermometer that is calibrated annually.

Rooting room: Relative Humidity

Once sufficient water is provided immediately after planting, no more watering is needed in the rooting room. It is advisable, however, to prevent the soil in the pots from drying out, so ventilation should be strongly limited. Opening the doors when checking temperature and r.h. provides enough ventilation. In addition, keep the r.h. of the air in the room as close to 95% as possible, and check this at several places regularly. If necessary, raise the r.h. by wetting the floor.

Standing ground: Introduction

Hyacinths can also be planted in a standing ground, but this method has certain drawbacks: the soil in the standing ground can harbor diseases, the temperature of the standing ground is difficult to control, frost damage can occur in the stack or during housing that takes place during a cold period, and the method is fairly labour intensive.
After potting up, the pots are put on the standing ground and covered with the soil from the standing ground. Just as with tulips, the pots can be placed on top of the standing ground soil or dug into it.
For additional information about this method we refer you to Chapter VI, "The standing ground". The total thickness of the soil cover for hyacinths, however, depends on the desired flowering period; for flowering up to and through January, a layer of soil 10-15 cm is used while a layer of ± 8 cm is used for later flowering.
For hyacinths, too, extra attention has to be given to the prevention of frost damage in the standing ground. Do not forget to cover the standing ground with an extra layer of blister padding when temperatures fall much below freezing. Make sure you always have this type of covering on hand.

Standing ground: Standing ground temperature

The ideal temperature for shoot elongation in hyacinths placed on a standing ground is also 9ºC. The same temperatures indicated for use in rooting rooms containing only hyacinths (Table 2) should be maintained. In contrast to the rooting room where the temperature can be precisely controlled, the use of a standing ground means that one is dependent on the prevailing ambient temperature. This can to a degree be modified by using a covering of straw. In the autumn, when the soil temperature is still slightly high, the temperature in the standing ground can be lowered by application of cold water and/or by covering the standing ground with an insulating layer of straw during the day. During winter, the straw layer (possibly with the addition of blister padding) ensures good insulation so that temperatures do not drop too low for the bulbs. Taking the temperature at bulb depth gives a good indication of temperature fluctuations.

Hyacinths can be planted as soon as the temperature in the standing ground is 13ºC or lower. If the standing ground temperature remains at this level for more than two weeks, compensation for lack of cold will be necessary. It is best not to plant cultivars susceptible to Fusarium until the standing ground temperature has dropped to 9°C.
Bulbs intended to flower after December have to be planted later due to their required cold period. However, planting has to be done when temperatures in the standing ground are above 5ºC for 2-4 weeks to allow for acceptable rooting to take place. If the standing ground temperature drops to between 5-0ºC after the rooting period, the cold periods indicated in the tables below should be extended by 3-4 weeks to compensate for this drop in temperature.

Whilst a sufficient amount of autumn rain could be expected, one must keep an eye on the moisture level of the potting soil, especially immediately after planting, and irrigation should be done as needed. Hyacinths should never be too damp, however.

Standing ground: Housing from the standing ground

When transferring the hyacinths during a period of frosty weather, the shoots can partially or completely dry out and freeze during transport. To avoid this, postpone the transfer or, if this is impossible, take the following actions:

- Quickly transport the bulbs to the greenhouse, preferably in the afternoon
- Do not remove the soil cover from the bulbs until after it has thawed out in the greenhouse
- Cover the boxes with plastic foil during transport
- To avoid damage, do rinse and water the bulbs not earlier than before they are in the greenhouse and have completely thawed out and
- To avoid desiccation of leaf tips, put plastic foil over the hyacinths for 24 hours after housing.

Housing

Hyacinths can be brought into the greenhouse from the rooting room or the standing ground as soon as the required cold period (number of weeks at 9ºC) has been achieved. Never house them too early. This leads to a much greater risk of quality problems like “top flowering” and top rot, as well as to an extension of the greenhouse period. Top rot is a condition in which the florets that were the last to differentiate, especially those on the largest flower clusters, dry out. The damaged areas then form entries for Penicillium mould which causes these florets to rot.

Temperatures above 9°C and under 5°C do not count as full cold for hyacinths, so that the cold period will have to be extended if the temperature remains under 5°C or over 9°C for longer than 2 weeks. Unfortunately, it is difficult to indicate by how long the cold period should be extended. The additional time can range from a few days to 3-4 weeks.
Water should be provided and the r.h. of the greenhouse air should be increased to 80% immediately after housing.

4. The greenhouse period

Greenhouse requirements

Hyacinths demand relatively little light during their production in the greenhouse and can be grown in any greenhouse, even in a storage area under artificial light if necessary. When hyacinths are the only crop being cultivated in the greenhouse, the humidity of the air can be high. This is why insulating the walls and the ridge of the greenhouse with insulating plastic foil is no problem. If tulips share the greenhouse space, the r.h. should ideally be kept at between 70-80%.
Unlike tulips, hyacinths react favorably to bottom heat; they flower earlier and also more evenly. Extra attention, however, should be given to the moisture level in the pots.

Greenhouse temperature

The greenhouse temperature depends on the time of year and the desired rate of growth. For flowering until 1 January, a temperature of 23-25°C is standard. For flowering during January, a lower temperature (23-20°C) can be used; for flowering in February and March, the greenhouse temperature can be 23-18°C. Cultivars susceptible to “crooked flower clusters” should be housed somewhat earlier as long as the number of required cold weeks has been completed, and then brought in to flower slowly at a temperature of 18-17°C. This modification should be applied to these cultivars until the end of January.
Always maintain a constant greenhouse temperature. Temperature fluctuations, even for brief periods, increase the risk of top rot. Hyacinths need a high relative humidity in the greenhouse, so keep the r.h. up to at least 80%, even in periods of below-freezing weather. Maintaining lower temperatures and a lower r.h. than advised encourages leaf growth and results in a plant in which the flower cluster remains inside the leaves. If the flower cluster does not elongate in spite of maintaining the advised temperature and r.h., a small rise in temperature can help. If, however, lowering the greenhouse temperature over the weekend is needed, ventilation will be necessary to prevent top rot.
Although artificial lighting is unnecessary in the greenhouse, use of lighting to extend the daylight hours during the darker winter period has a beneficial effect on the crop. Applying additional light and extended periods of illumination results in more rapid coloring of foliage and flowers, a more rapid spread of the leaves, and an improvement in keeping quality.

Watering

During cultivation, sufficient water should be provided to keep the potting soil at a normal moisture level. Never over-water, but do not let the soil in the pots dry out, especially when using potting soil. Once potting soil dries out, it absorbs water poorly. This is why a daily check is essential. Do not irrigate with water that is too cold since this will cause the temperature in the greenhouse to drop too low. This rule also applies to the water meant for maintaining the r.h. of air in the greenhouse. Provide water in the mornings; this allows the crop to dry before evening.

Forcing under artificial light

Just as with tulips and narcissi, hyacinths also grow well under artificial light. This method is similar to greenhouse cultivation.
Although it is possible to grow hyacinths in limited light conditions, the amount should be sufficient and applied in such a fashion as to prevent a limp, pale crop. The following guidelines are given:

- use TL lamps with a capacity of 36 watts/m2 and incandescent lamps with a capacity of 150 watts/m2. For either type of lamp, use reflectors
- the distance between the lamp and the top of the crop should be 1 meter
- when using a high-pressure vapour discharge lamp (400 watts), such as a HQIT (Osram) or a HPIT (Philips) lamp, use one lamp per 10 m2. The distance between the top of the crop and the lamp when using a wide-beam 2 type of reflector or when using a concentration-type 3 reflector should be 3 meters
- the duration of illumination lasts 12 hours until mid-January, 14 hours from mid-January until mid-February, and 16 hours thereafter. Based on recent experience, 24-hour illumination throughout the entire season is preferable
- higher light intensity and longer periods of illumination have been shown to improve quality, however it is advisable to try on a small scale initially
- it is advisable to paint the walls of the room white or to cover the walls with reflective material.

5. Harvesting and preparation for sale

Harvesting

Pot hyacinths are harvested once the flower has reached the required stage. If harvested at an early stage, the products are called “sprouted hyacinths”. Even for these, though, a limit should be placed on how early they can be harvested. The flower should have grown at least 5 centimeters out of the bulb. Only then can the quality of the flower be guaranteed.
If the hyacinths are intended to be planted in bowls, etc., harvest usually occurs when the florets of the flower have separated from one another.

Preparation for sale

After harvesting, hyacinths are graded according to maturity, height, number of florets and firmness. The soil in the pot must also be moist enough, and the pot clean and undamaged. If the hyacinths are sold with the pot, it is a good idea to use an attractive pot and provide it with a colorful product label (illustration of mature product along with directions).

Storage

It is best to market pot hyacinths immediately they are ready as they are not very suitable for storage at low temperatures. Most cold-storage rooms have a high r.h. that encourages top rot caused by Penicillium. Temperature fluctuations can also cause top rot. If the hyacinths must be stored for a few days, this can be done once the florets have separated from one other. It is essential to keep the temperature at ± 2°C with good air circulation to keep the plants as dry as possible.

Long-term storage

It is best to have a production schedule for pot hyacinths so that the market-ready product spends as little time as possible in storage. If storage is unavoidable, which can happen before important holidays such as Christmas and Valentine’s Day, optimal conditions should be provided:

- Put the hyacinths in cold storage as soon as the florets separate
- Maintain a temperature of 0.5 to 1°C
- Ensure sufficient air circulation via circulators or by having cooling circulators turned on constantly
- The potting soil in the pots should not be too wet
- Always keep the leaves and the flower cluster dry
- These conditions allow a storage period of 2 to 3 weeks

6. Hyacinths as cut flowers

Introduction

Many aspects of the cut flower production of hyacinths are similar to growing hyacinths in pots. The following description of growing cut flowers will therefore discuss only the specific differences between the two methods.

Steps in planting

The best containers for growing the bulbs are trays or boxes 16-18 cm. deep. This depth is important as it allows the bulbs to be planted at ± 8 cm. Later, the plant develops more height and the leaves are more firmly attached around the stem. The distance between the trays in the rooting room needs to be greater than for pot hyacinths, because cut hyacinths are given a longer cold period and they develop taller shoots.
The best planting medium for cut hyacinths is made from sand or potting soil using a large percentage of sand or garden soil.

Housing

The big difference between growing pot and cut hyacinths is the length of the cold period. With cut hyacinths, extra stem length is desirable to make a good bunch; this is achieved with a longer cold period. More cold induces greater length. The table details the required cold periods for cut hyacinths.

After the recommended cold requirement is completed, the boxes can be removed from the rooting room or standing ground, and then housed. If bulbs have come from a standing ground, they should be covered with plastic foil for 24 hours after housing. This prevents leaf tips from drying out. Water is provided immediately after housing.

Greenhouse environment

Throughout the season, cut hyacinths are grown at a greenhouse temperature of 18-20uC to obtain as much length as possible. The greenhouse period,
lasting ± 20 to ± 10 days, depends on the depth and temperature of the substrate layer at the time of housing.
Water regularly during forcing to keep the planting medium at a normal moisture level. If the planting medium consists entirely or partially of sand, care must be taken to avoid drying out. Regular checks for moisture level should never be neglected.

Harvesting, preparation for sale

Cut hyacinths are harvested when the flower cluster shows color and florets separate from the stem. The flowers are removed from the trays along with the bulbs. Next, it is important to place the hyacinths as soon as possible in a cold storage room at 2°C. This brings the flower temperature to the desired level for packaging.
The bulb is removed from the stem during preparation for sale, but a piece of the basal plate is left attached to the stem. This work can be done manually, or mechanically with a "hyacinth bulb removal machine". By leaving the basal plate attached to the stem, the flower opens better in the vase and it's keeping quality is improved. It is important, however, that neither the retailer nor the consumer remove the basal plate.
After bulb removal it is important to rinse the stems with clean water; this prevents bacteria growth and ensures a clean product. The flowers are then graded according to length to make bunches with stems of equal length. Unlike other flowers, hyacinths can no longer be cut to length because doing so would cut off the basal plate. After grading, the hyacinths are bunched in five's and stored dry (max. 3 days). For better quality, however, it is preferable to store them in clean water with the recommended addition of one tablet of chloramine T (Florissant 500, for example) per four liters of water.
If the flowers must be stored, this can only be done for a short period (max. 3 days) in a cold storage room set at 2°C. Two final tips for the consumer: 1.) do not cut off the basal plate, and 2.) rinse the stems well with clean water before you put them in a clean vase.

7. Crop protection, diseases and disorders

General soil treatment

To prevent disease problems in the standing ground it is advisable to use a fresh area annually. This makes a general soil treatment of standing ground soil unnecessary.

When standing ground soil has previously been used and will be reused to fill the pots or cover the bulbs, it is advisable to give this soil a general soil treatment to avoid Rhizoctonia solani attack. This general soil treatment is identical to the treatment given before using the soil for tulips. For additional information concerning general soil treatment, we refer to "General soil treatment" or your local information sources.

Bulb treatment

For information concerning the various methods of treatment, we refer you to Chapter XIV, "Bulb treatment" in the tulip section.
The first line of defense for controlling fungus disease is to follow the proper steps in cultivation as described in the previous text. For information concerning treating bulbs to prevent fungus, we refer you to the International Flower Bulb Centre's monthly Information Bulletins, your local information service, and your supplier. If, however, you are able to give the hyacinths 9°C starting from the planting date, and if the bulb shoots are fully exposed and not covered with soil during the cold period there is no need to give a fungicide treatment.

Fungal diseases: Parasitic top rot

Plants that have a few to several rotting florets located in the top part of the flower cluster are said to have "top rot". This is often accompanied by brown leaf tips.

- Cause

The actual rot is usually caused by opportunistic parasites that do not invade the plant until the florets have become desiccated (physiological top rot) or when they have already been affected by fungi and pests (parasitic top rot). The following can cause a primary attack:

- Rhizoctonia solani

This fungus attacks the plant from contaminated soil even before housing. It can be recognised by the irregularly shaped, light brown indentations on some of the florets. It can also show up to a lesser degree on the outer sides of the outermost leaves. In a more serious attack, the spots are larger and the leaf tips become brown, and a cobwebby-looking fungal growth can be noticed upon housing. This infection often occurs in patches, and the degree of infection increases as soil temperatures rise.

- Fusarium

This fungus can attack the roots once they have emerged from the bulb. Once infected, whilst the root tips remain white, the ones towards the root crown rot. The water supply to the bulb is thus interrupted, leading to desiccation of the florets, usually followed by top rot and/or stunted plants. Main factors affecting fungal growth are: temperatures over 9°C and housing following an insufficient cold period.

- Tabaci thrips

A thrips infestation (thrips are small, elongated brownish-black insects) is recognised by small white spots on foliage leaves and florets. This is caused by insects sucking young plant tissue. At a later stage, these spots die and turn brown. The florets dry out and form a food source for opportunistic parasites. The infestation only occurs in rooting rooms, and increases as the temperature rises.

Prevention

- Always use new standing ground soil and potting soil. Contaminated soil should be given a general soil treatment before use
- Maintain the prescribed temperatures in the standing ground and rooting room

Fungal diseases: Penicillium (storage rot)

The first symptoms, seen immediately before planting, are the emergence of a few dried root tips with fungal growth. Upon cutting the root crown, the surrounding tissue shows a light brown color. Tissue of the same color can also be seen at points where bulblets have broken off. The decay process in the bulb continues during storage and also after planting. Shoots of infected bulbs remain shorter, and the bulbs themselves have few or no roots. The plant falls over easily.

This fungus also occurs on injured areas on the bulb. Areas affected develop a white to blue-green fungal growth. The underlying tissue becomes soft and brown, but the attack does not extend to the basal plate and does not have an adverse effect on flower quality.

Cause

These attacks are caused by various Penicillium fungi such as P. verrucosum. ‘Pink Pearl’ and its sports are especially susceptible to an attack via the root wall. The chief cause of this attack is low storage temperatures (under 17°C) combined with an r.h. higher than 70%. Another cause is injury to the bulbs.

Prevention

- Prevent premature sprouting/emergence of the root tips, and plant the bulbs immediately after receipt (especially ‘Pink Pearl’ and its sports)
- During storage, maintain the recommended temperature and ventilation/circulation. The relative humidity in the store should be kept under 70% at all times.

Bacterial diseases: Erwinia (soft rot)

In the greenhouse, seriously affected bulbs produce no shoots. Bulbs are soft, and the bulb tissue is glassy with a dirty white or yellowish color. These affected bulbs have a very unpleasant odour. With less serious attacks, the leaves develop wet, dark green, elongated areas that run upward from the leaf base. At first, growth is retarded; later, the plants collapse and decay.

Cause
This disease is caused by a bacteria, Erwinia carotovora. This bacteria is chiefly an opportunistic parasite and mainly attack tissue injured by frost or excess water. Other points of entry, when the temperature is too high or when the soil is too wet, are wounds caused by premature rooting or places where bulblets have broken off. This problem occurs mainly when standing ground temperatures become too high and the soil becomes too wet during the autumn. 'Delft Blue' and 'Carnegie' are very susceptible cultivars.

Do not confuse this disease with "yellow disease". This disease, which is not contagious in the greenhouse, looks like "yellow disease", but the affected tissue is usually butter-yellow in color and the problem never occurs in patches.

Prevention
- Always plant bulbs as recommended on standing grounds or rooting rooms that are cool (9°C) and not too humid
- Remove infected bulbs and plants upon housing and throughout the entire greenhouse period. This prevents Erwinia bacteria from spreading to neighbouring bulbs via irrigation water.

Physiological disorders: Physiological top rot

The rotting top of the cluster determine the name of this disease. This kind of top rot also shows many rotten florets in the top part of the flower cluster. The leaves, however, are usually undamaged. The first symptom of physiological top rot - white instead of creamy-colored florets - always shows up during housing or shortly after. Stamens of these florets are somewhat glassy, faded or shrivelled. Under warm, humid greenhouse conditions, these dying florets form an ideal location for ever-present decay bacteria (such as Erwinia), fungi and mites.
If the attack is caused by Erwinia bacteria, the affected florets are greyish white (later turning brown). They are wet, smelly and decayed. Neighbouring florets look glassy. An attack by Penicillium fungi results in blue-green, rotten florets. In a later stage of cultivation, especially when plants are market-ready, the fungi can attack the top florets, usually affecting heavy flower clusters. These florets remain greenish while the stem in the vicinity is brownish-red and blue-green fungal growth can be found between the florets. This problem develops if market-ready hyacinths are held under cold, humid conditions.

Cause
The primary cause of physiological top rot is the desiccation of the last florets to be differentiated, a problem caused by insufficient cold treatment for that cultivar. Susceptibility to this kind of top rot depends on the cultivar and the bulb size. 'Pink Pearl',

for example, is more susceptible than ‘Anna Marie’. The heaviest flower clusters are also more susceptible. Secondary attacks by opportunistic parasites such as Erwinia bacteria and Penicillium fungi attack the desiccated florets and then move on to neighbouring florets. If unaffected by a secondary fungal attack, the florets remain desiccated (“blind florets”).

Prevention

- Make sure that the rooting rooms and standing ground used for planted bulbs are kept at a constant temperature of 9°C. Variations to 9°C call for compensatory measures
- Do not house the bulbs too early; take the necessary cold requirements of the various cultivars into account
- Maintain a constant temperature of 23-25°C during the greenhouse period. Never lower the temperature more than 1-2°C during cultivation as this increases the risk of a Penicillium attack in the flower caused by a very high r.h. in the greenhouse
- Never, especially in the final stages, apply water over the flower clusters
- If unable to avoid storage before delivery: do not make the soil in the pots too wet, and make sure to provide sufficient air movement between the plants.

Physiological disorders: “Green tops”

A number of florets in the top of the flower cluster remain green; in serious cases, this affects the entire top of the flower cluster.

Cause
The causes of this disorder are the result of incorrect cold treatment: either too short, or a wrong temperature was applied which has the same effect. Some cultivars such as ‘Pink Pearl’ and its sports and ‘Jan Bos’ are more susceptible to this disorder than others.

Prevention

- After planting, use the recommended cold period and cold temperature.

Physiological disorders: “Crooked flower clusters”

The uppermost part of the flower stalk grows crookedly once the bulbs have been brought into the greenhouse.

Cause
In heavy flower clusters, one part of the stem and its attached florets develop slower than the rest. This is an undesirable trait of certain cultivars such as ‘Delfts Blue’ and its sports, ‘Carnegie’, and ‘L’Innocence’. It occurs particularly in the earliest batches to flower and in hyacinths with heavy flower clusters.

Prevention

- After planting, use the recommended cold period and temperature.
- Maintaining a lower greenhouse temperature (18-17°C) also limits the occurrence of “crooked flower clusters”

Physiological disorders: “Top flowering”

In contrast to normal growth, the uppermost florets bloom before the lower ones. The flower clusters are usually short and stocky.

Cause
This disorder occurs as a result of not meeting the cultivars cold requirement before housing the plants. The susceptibility to this disorder differs for each cultivar.

Prevention

- After planting, use the recommended cold period and temperature.