Floricultura
ORCHIDACEAE & ARACEAE

Cultivation manual
Phalaenopsis pot plants

Initial propagation phase

Substrate and initial phase of young plants supplied in flasks

Plants that are supplied in plastic flasks, straight from the laboratory, must be pricked out in a warm area, into trays containing, say, a mixture of 90% bark and 10% sphagnum (with the optional addition of perlite or foam). After around six months the plants can be transplanted to 12 cm pots. Nowadays the plants from the tissue-culture trays can also be transferred to special plugs, after which they can be planted directly in 9-12 cm pots after about 24-28 weeks.

Substrate and initial phase of young plants supplied in plugs

Plants supplied in plugs measure about 10 to 15 cm from leaf tip to leaf tip. They are to be planted in transparent 9-12 cm pots. Transparent pots are better for the plants' root development. Various organic mixtures with good drainage and air-retention capacities can be used as substrate. The basis is bark, supplemented with a little sphagnum (10 to 15 % by volume), coir or peat fibre or granules. Different substrates have different water needs. Immediately irrigate and fertilise your plants via the overhead irrigation pipes. Carefully check your crop to see whether any plants need extra watering by hand; this is also a good way of monitoring your crop. Irrigate your plants every four to six days, depending on the type of substrate and the climate conditions. The pots should be dry after four to six days. If the pots are still moist then and you postpone irrigation, you will run a risk of irregular growth and more losses. Check the EC of the drainage water. If it is increasing you will have to irrigate your crop with clean water and increase the heating and ventilation to get the pots to dry well. Substrate that remains wet for too long will readily collapse, resulting in rooting problems.

At first, arrange your plants close together, in a density of around 70 to 90 plants per net m^2 of bench space. After 16 to 18 weeks they must be spaced further apart to obtain uniform batches. In the second propagation phase the plants must be at a density of between 40 and 60 (with collars) per m^2. This may also be the cooling density. After 8-10 weeks when the plants have formed four mature leaves they may be transferred to the spike-initiation (cooling) and final propagation sections. The cooling section may be combined with the final propagation section. By this stage the density must be around 40 to 50 plants per m^2, so almost half that of the initial propagation section.

The aforementioned numbers will depend on the cultivation system, and may vary according to the weight of your plants (slow or fast cultivation), the size of your pots (6, 9, 12 or 15 cm), the use of collars on the pots or flasks, and the growth rate. Spikes should have formed after around six to eight weeks. It will then take another twelve to fourteen weeks before the plants are ready for delivery, with open flowers. The growth rate will depend on the season, the employed cultivation method and the variety.

Temperature

The recommended temperatures in principle are as follows:

1. 27-28°C during the day and no lower than 26°C at night during the initial propagation phase;
2. 18°C at night (of at most 12-14 hours) and 20-22°C during the daytime for at least six weeks during the spike-initiation and final propagation phase. A distinction may be made between the latter two phases, in which case the temperature may be on average 1 to 2°C higher in the final phase if this can be realised in a separate area. This will result in a slightly better quality while shortening the final phase. Night temperatures lower than 18°C will cause the plants' growth to stagnate and the leaves to discolour, with the added risk of bud drop. Best is to ensure a leaf temperature of at least 18°C.

The conditions outlined above will enable good annual planning. As we are able to supply plants on a weekly or monthly basis, you will also be able to pot plants every week or every month and transfer them to your spike-initiation and final propagation section at the same frequency, enabling you to supply flowering plants all the year round.

Light

Light plays an important part in the cultivation of Phalaenopsis. The minimum light intensity for young plants in the initial propagation phase is approx. 4,000 lux, which must then be gradually increased to 8,000 lux, approx. 70-140 μmol/m²/sec. More light will involve the risks of inhibited growth and discolouration of the leaves. All cultivation conditions must be adjusted to increase the light intensity. In practice this will mean that the greenhouse roof will have to be whitewashed more than once from the end of February until mid-October, and that you will need one or two screens to prevent too much light in this period. Grow lighting on dark days will improve the propagation conditions. In the 1st propagation phase the daylight sum must be 3.0 to 4.5 mol per day. In the 2nd phase the lighting may be increased to 4.0 to 6.0 mol at an average intensity of 5,000 to 7,000 lux, 90-120 μmol/m²/sec. (see the table). After about six months most of the plants will be large enough (4-5 mature leaves) to be transferred to the spike-initiation/final propagation section.

The minimum light value must be the same as the value in the 2nd propagation phase, but experience gained in trials and in practice have shown that light values between 7,000 and 10,000 lux (120 to 180 μmol/m²/sec) lead to excellent spike initiation and flowering results. This corresponds to a light sum of between 5 and 8 mol per day. When the plants are spaced further apart they will of course receive more light. The costs of more intense lighting and climate adjustments may exceed extra profits. The maximum day length for Phalaenopsis is 14 hours. Days of more than 14 hours realised with grow lighting will involve the risks of inhibited growth and red discolouration of the leaves, especially in the case of greater light intensities.

Recommended lighting of Phalaenopsis at a day length of 12 hours

Phase	Maximum intensity (μmol $m^{-2}s^{-1}$)	Maximum PAR sum (mol/m² day)
vegetative I phase	70 - 90	3 – 3.5
vegetative II phase	80 - 110	4 – 4.5
cooling phase	150 - 170	6 - 7
final phase until flowering	130 - 150	5.5 – 6.5

These values are based on cultivation without vases or collars. Especially in the case of cultivation in vases or collars, the plants will need around 25%-30% more light for the total amount to be on balance the same as that of plants that are cultivated without flasks. This is because of the different positions of the leaves and the shade created by the plastic.

Water

Water is one of the most important factors in growing plants. Only rainwater or reverse osmosis water is suitable for Phalaenopsis. Other types of water will lead to problems. Make sure you have a sufficient supply of water if you have a small tank with a reverse osmosis device. Your plants will need at least 10-15 litres per m² per week. The plants can be irrigated from above via a rainwater pipe or an irrigation boom. The shorter the irrigation, the less wet/saturated the pots will be. A dose of between ten and fifteen litres a time will be enough. Early on at first four to six weeks after planting, a smaller dose of four to six litres may be better to ensure faster rooting, certainly in the case of plants in plugs. It's better for plug plants to be a bit drier than plants from propagation trays in the initial propagation phase. The size of the water dose will depend on the number of plants per m², the size of the plants and whether or not you are using vases or collars. Your irrigation capacity must be about 1/2 litre/min/m². If you are using a reverse osmosis system, check the concentration of boron in the water leaving the system. That may vary from one area to another, and high concentrations may damage the plants.

Temperature of the irrigation water

The recommended temperatures of the irrigation water in the different sections are as follows:

1. initial propagation section: minimum temperature 20-22°C
2. final propagation section: minimum temperature 20°C

These temperatures can be realised with the aid of a counter-flow system.
Note, water of higher temperatures contains less oxygen.

Relative humidity

A good relative humidity of between 60 and 80% is important for good growth and flowering. When the light intensity increases, the relative humidity will also have to be raised. Values of more than 80% for short spaces of time are quite acceptable subject to sufficient discharge of moisture, which can be realised via simultaneous heating and ventilation (to ensure adequate air circulation in the greenhouse). Long periods with a relative humidity of more than 80% may lead to soft growth, making the plants more susceptible to diseases.

There is no need for misting if the relative humidity drops below 60% for short lengths of time. At high light intensities there will be a greater risk of discolouration at a low relative humidity. It is not necessary for the recommended values to be realised 24 hours a day. The greatest problems will occur if the relative humidity drops or rises very quickly. A high ventilation factor or an uneven distribution of heat will involve a higher risk of Pseudomonas infections (bacterial brown spot caused by Acidovorax avenae spp. cattleyae). Because of the high temperatures at which the plants are grown it will for the greater part of the year be possible to dehumidify the greenhouse by opening the vent windows and screens a little bit.

Fertilisation

The plants are to be fertilised along with the irrigation water. The composition of the fertiliser will depend on the time of year and the stage of the plants' development. Although you can use single and/or liquid fertilisers, it will usually be more practical to work with compound fertilisers.

In the initial propagation phase a combination of calcium nitrate, Plantprod or Peters 20-20-20 (with urea) and magnesium sulphate in a ratio of 2:6:1 will be excellent dosed via a two-tank system. You may also add supplementary iron. In the winter it is advisable to lower the nitrogen (urea) dose for plants grown without lighting. This can be realised for example by giving your plants a slightly higher dose of calcium nitrate or by replacing part of the 20-20-20 by 7-11-27. Plants will need extra fertilisers at high light intensities. However, there will then be a higher risk of the EC of the substrate increasing and the pH decreasing, with the associated risk of Fusarium infections and poor roots. Ammonium should be restricted to avoid the risk of a sudden drop in the pH causing root problems. Urea is a safer, better choice, though it should be borne in mind that the urea dose should be lowered in the case of wet substrates combined with high temperatures.

In the spike-initiation and final propagation phases the nitrogen dose must always be adjusted in winter as mentioned above. However, such correction may be necessary in summer too, in the case of extremely hot weather. At temperatures higher than 28°C the amount of nitrogen contained in the standard solution is too much. It would lead to rank growth. Standard fertilisation of 1 EC is usual in substrate. The EC of the drainage water may vary between 0.8 and 1.2, depending on the growing conditions. A regular (once a month) dose of clean water may prevent the risk of the EC in the pots rising too much. Closely monitor the pH; if it drops too much, adjust the ammonium and urea doses after adding Dolokal to the substrate. An indicative dose is 1.5-3 kg per m^3; this will depend on the growing mediums.

Pests and diseases

Chemical control will not usually be necessary in a healthy crop that is regularly checked for symptoms of the most common pests and diseases. In the case of effective biological control you may see a lot of spiders during the initial propagation phase. The cobwebs may look unpleasant, but the spiders will be eliminating a lot of pests, largely precluding the need for chemical control.

And when the plants are transferred to the cooling area the low temperatures will make them disappear. The following disorders, pests and diseases may affect Phalaenopsis:

- Bud drop
  Bud drop is observed mainly in autumn and winter, as a result of insufficient light, poor roots or a low relative humidity combined with high temperatures. It may also occur during periods of snowfall.
- Thrips
  Thrips may cause deformed leaves and flowers. They can be biologically controlled with the predatory mite *Amblyseius swirskii*.
- Erwinia and Pseudomonas bacteria (Acidovorax avenae spp. cattleyae)
  Plants that become weak and straggly due to too much nitrogen and too little calcium, too high temperatures during propagation, a too high relative humidity and insufficient ventilation will be more at risk of Erwinia and Pseudomonas infections. Carefully remove infected plants before each irrigation session and optionally spray affected areas with a product containing hydrogen peroxide. Make sure the relative humidity is not more than 80% for long periods. Various systems for continuous disinfection of irrigation water are commercially available. Also important is to regularly clean (the floor of) your water tanks, or have them cleaned.
- Mites (moss mites)
  Moss mites are shiny round mites that can cause deformed main shoots and damage flowers. Mites are observed mostly on hot, moist summer days. Spray the plants with an acaricide shortly before transplanting them. The mites are active after irrigation, so that's the best time to control them.
- Tenuipalpus (formerly Brevipalpus), flat red mites
  Tenuipalpus cause discolouration of the bottom of the leaves.
- Scale insects and mealybugs
  Scale insects and mealybugs are observed on the bottom sides of leaves and in buds and flowers. The grey round insects or slow, pink or orange bugs with a powdery wax coating are to be found in groups in leaf axils or in buds and flowers.
- Fungus gnats (Sciara)
  Fungus gnats inhibit the growth of young plants in particular. They can be effectively biologically controlled with Hypoaspis mites immediately after transplanting.
- White worms (Lyprauta)
  The larvae of Lyprauta (several species) feed on root tips. They are most active in wet substrates, so make sure your substrate can dry sufficiently and quickly. Apply Macro-mite (Macrocheles robustulus) immediately after transplanting your plants. Light traps may also be fairly effective. If all else fails, use approved chemical control products.

- Caterpillars
  Caterpillars can cause a lot of damage by feeding on flowers and leaves. Look out for moths and butterflies by using pheromone or light traps. Make sure your windows are closed where possible when your lamps are switched on, or else you will be attracting insects into your greenhouse.
- Mice
  Mice eat the pollen of the flowers of some varieties. They may get into greenhouses when it rains and/or when winter approaches.
- Slugs and snails
  Slugs and snails may be observed among wet plants, and should then be controlled, either with pellets or biologically, with nematodes. Good hygiene on and around your greenhouse premises is of course also important, e.g. removing any weeds growing under your benches.

We strongly advise you to carefully read the labels on the packaging and/or consult an expert concerning the use and doses of control products. When using a new product, always test it on a few plants first.

Greenhouse layout

Sections

For Phalaenopsis pot plants you need at least two separate cultivation areas:

1. An area for the initial propagation phase in which the plants with an initial size of 10 to 15 cm are to remain for around six months (vegetative phase) and starting from plugs.
2. An area for the spike-initiation and final propagation phases in which the plants are to remain for around five months (generative phase).

Under optimum cultivation conditions the ratio of the two areas should be 45:55. Sorting and processing areas will usually form part of the final propagation section. In practice there will usually be two initial propagation areas and separate cooling and final propagation areas.

Benches or mobile containers

Phalaenopsis are grown on benches or in mobile containers, preferably with an open-mesh base. They may be made of various materials. Make sure there is enough room to walk or drive between the benches or containers to inspect the plants. We advise you not to use eb-flood irrigation because of the risk of the accumulation of salt due to insufficient rinsing of the substrate. Common bacteria, viruses and fungi may be transmitted via the water. And in the case of a closed bench one sick plant can easily infect the other plants via the common water.

Heating

Your heating system must be capable of ensuring a temperature of at least 27°C day and night during the 1st propagation phase and a temperature of at least 20°C in the daytime and at least 18°C at night during the spike-initiation and final propagation phases, irrespective of the outside temperature. We advise you not to use lower temperatures.

Screening

A screening system is essential in growing Phalaenopsis, both for saving energy and for preventing too much light. Most nurseries have two, and in some cases three screens to ensure optimum control of light and climate conditions: one screen of an open-weave fabric as the main screen plus a lighter screen with a closed structure. An outdoor screening system offers excellent possibilities for ensuring a cool final propagation phase without any need for whitewashing, while also reducing the required lighting and cooling capacity.

CO_2 system

Phalaenopsis belong to the group of CAM plants, which absorb CO_2 different from other plants, and mostly at night. The process may already have started in the afternoon, after the plants have received light from a lighting system for twelve to fourteen hours. This is something that should be borne in mind, do not start artificial light before 5-6 AM in winter. Providing CO_2 during cooling and the final propagation phase improves flowering by 15% in the form of a larger number of spikes per plant and/or more flowers per spike.

CO_2 is also important in the initial propagation phase when plants are grown at higher light intensities. CO_2 reduces the risk of yellow discolouration. At high light intensities the plants will open their stomata earlier (before it gets dark), and will then be able to absorb CO_2 even while it is light. Values of 600 to 800 ppm (parts per million) may accelerate growth and increase the number of spikes and flowers per spike. We do advise you not to go beyond approx. 1,000 ppm. Use pure CO_2 to prevent the risk of damage by NOx and ethylene.

Grow lighting

In most countries, including the Netherlands, nurseries need grow lighting to ensure the required light intensities during the final propagation phase in the winter months. Such a system is also advantageous in the initial propagation phase, especially for the development of the roots and formation of leaves. It must have a capacity of at least about 5,000 lux. Up to 10,000 lux grow lighting may improve spike initiation, resulting in for example a higher percentage of plants with more than one spike. But more light is not always a good thing, because the light intensity has an influence on the plant temperature, greenhouse climate, CO_2 concentration and relative humidity. At high light intensities you will also have to adjust your water and fertiliser doses. High light intensities may shorten the flowers' life once the plants have reached consumers. Consumers' homes may be a lot darker than a nursery's greenhouse, and this may lead to bud drop. Plants with open flowers are a lot less susceptible to bud drop and other keeping-quality problems.

Cooling (air-conditioning) system

Many nurseries have a cooling (air-conditioning) system to be able to ensure a night temperature of 18°C in the summer months, as required for good spike initiation. In daytime the temperature should rise as little as possible, preferably not above 22°C. A 24-hour average temperature of 19-20°C is ideal. Night temperatures above 19°C adversely affect spike initiation, while day temperatures above 22°C result in fewer flowers per spike, and temperatures of 23°C and higher also lead to fewer plants with more than one spike. At such high temperatures the elongation of the first spike will proceed excessively.

A good cooling system will enable far more effective planning and year-round production. Dutch growers are advised to install a system with a capacity of about 150-250 Watt/m² so as to be able to ensure an average greenhouse temperature of 20°C on hot summer days. High light intensities call for a lower average temperature (19°C) to prevent the risk of scorch damage. Nurseries in hot (Mediterranean) regions will need a system with a greater capacity of up to 250 Watt/m² to realise comparable results. If you use only a pad and fan system in the daytime you won't have any plants flowering in autumn. A pad and fan system with slightly less air-conditioning during the night will offer you a reasonable possibility of year-round flowering, though your schedule and the quality of your plants will not be perfect. You could also consider a combination of these options, possibly with misting, a roof-spraying system or an outside screen.

Production

The production of a modern nursery with 84% of the available space being used (that can be realised with mobile containers or benches) will be between 45 and 55 plants in 12-cm-pots per m² of greenhouse area per year in the case of the right cultivation conditions. This will be approx. 20% lower in the case of fixed benches. Automated nurseries with systems for sorting the fully propagated plants will be able to produce more than 60 plants per m² of greenhouse area per year. The actual production will depend partly on the range of varieties grown, the growth rate and the loss percentage. Loss percentages of less than 5% are to be expected; higher losses will be due to specific cultivation conditions and/or the susceptibility of the variety grown.

Use of available greenhouse space (for plants in 12 cm pots)

Phase	Plants/net in m²	Period in weeks	Required space in %
vegetative I phase	80 - 90	16 - 18	aprox. 30
vegetative II phase	40 - 50	8 - 10	aprox. 15
cooling phase	40 - 50	6 - 8	aprox. 17
final phase until flowering	40 - 50	12 - 14	aprox. 38