Production of Cuttings at Alkemade Brothers: Observations on Quality Control and Use of Light Emitting Diode Lights©

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INTRODUCTION

The business was established by Theo Alkemade in 1990 as a cut flower nursery and then began producing rooted cuttings on a small scale as a second crop. A few years later his twin brother Wil joined the company and they started specialising in rooted cuttings. As the company developed it expanded to four locations approximately 5 miles apart, which was not very efficient. An opportunity to relocate the whole company to one location arose in 2011. The new location is 30,000 m^2 and includes 28,000 m^2 of greenhouse. In 2012, approximately 17 million cuttings of more than 1,000 taxa were produced, half of them are sold in the Netherlands the other half is exported, mainly across Europe. This is achieved with a workforce of 12 and there are up to 15 part-time workers during the busiest periods.

Theo and Wil don't want to expand further, so the business will develop by producing better quality cuttings and using the space more efficiently. This can be done by growing the cuttings in a bigger size tray, producing a bigger plant which will give our customers a head start and the chance to produce an extra crop each year.

THE NEW NURSERY

With four locations, one major problem was that the greenhouses were of different sizes which made modernisation nearly impossible. The new nursery gave an opportunity to start from scratch in a single empty greenhouse.

First a water drainage and recycling system was installed in the floor and covered with a layer of crushed lava. The floor heating system was placed on top of that and this was also covered with a layer of lava. After that the lava was covered with anti-rooting sheets. In the old nurseries the trays of cuttings had been stood on sand beds. The lava floor drains the water much faster than a sandy floor. The biggest benefit of this is that there are fewer root problems in the autumn and winter.

A rail system was placed on every bed to carry trolleys for picking orders. The trolleys are taken to the dispatch area with electric transport carts. We also have a a trimming machine that rides over these rails which makes trimming a one-person rather than two-person job and it also gives a significantly better trimmed quality than we were able to achieve with the old set-up because it is now possible to always trim the cuttings on time. Our existing spraying machine was adjusted to enable it to ride over these rails, too resulting in more even spraying.

In the old nurseries there were six rooting areas with a capacity of 800,000 cuttings, in the new nursery two rooting areas were constructed with a capacity of 1.6 million cuttings. With just two areas it is now much easier to monitor how the cuttings are growing and provides the opportunity to react fast if things are not going as planned.

THE PRODUCTION PROCESS

Unrooted cuttings can now be bought-in more efficiently to the new facility which helps to improve quality throughout the production process. The process is based on how long it takes for a rooted cutting to be ready for sale. If it takes 10 weeks and the customer wants the cuttings in Week 25, the cuttings will be stuck in Week 15. This way the customer gets a fresh cutting and it is less work to prepare them ready for delivery, as well as reducing the risk of losses before dispatch.

The business aims to use a minimal quantity of mother stock. By buying the cuttings un-rooted it is possible to plan production more efficiently. Boxes of unrooted cuttings arrive from all over the world to the nursery every day of the week. Cuttings are bought

from a range of different places to reduce the risk of disruption caused by environmental or political problems. Once the boxes arrive at the nursery they are immediately unpacked. The cuttings are also inspected for pests and diseases. If they are unhealthy they are thrown away. After the inspection the cuttings will be watered and placed in a controlled climate cabinet and from here they will be stuck as soon as possible.

Chlorophyll Fluorescence Meters for Quality Control

All inspections are visual. This works in most cases but sometimes early stages of infections are missed. In the near future we plan to use chlorophyll fluorescence to help us inspect cuttings.

Chlorophyll fluorescence measures photosynthetic activity, which is reduced in unhealthy leaves and low activity can be a sign of disease even if there are no visible symptoms.

There are several different ways of doing this. There are cameras that can scan the cuttings so that any infected tissue shows up bright on the image while healthy plants show almost no sign of fluorescence. However these are currently very expensive.

There are more affordable handheld meters already on the market. They are placed against a leaf and display a reading, usually as a percentage. The reading is generated within a few seconds by shining two light emitting diodes (LED) onto the leaf in quick succession. The first LED emits light equivalent to what the leaf perceives as darkness. This means the chlorophyll absorbs approximately 80% of the available light from the LED and the other 20% will be reflected and is measured. The second LED emits light at twice the intensity of daylight. The chlorophyll cannot process this amount of light and the overdose brings photosynthesis to a momentary standstill when most of the light is reflected as fluorescence. The meter provides a reading by comparing these two results. 80% is the maximum in a healthy plant and when the reading drops below 40% then the leaf is in poor condition and if no action is taken it will die. Cuttings with a reading lower than 40% should not be planted.

Chlorophyll fluorescence meters can also be used for other checks, such as the effectiveness of fungicide sprays (take a measurement before spraying and another one an hour after spraying) or to check for damage after using a herbicide. It is also possible to use the meters to time deployment of shade screens — the screen should be closed before the fluorescence reading falls below 40% to avoid damage resulting from too much sunlight.

Sticking the Cuttings

Trays already filled with rooting medium are bought into the sticking area. We buy media in compressed bales – 1 m^3 of compressed bale yields 3 m^3 of medium. Thiacloprid (as Exemptor) is added to the medium, to control sciarid fly larvae, together with a slow acting mini Osmocote fertiliser which releases over five months to give even growth. The fertiliser becomes active after 2 weeks, this gives the cutting time to root and as soon as the first roots are there, the nutrients are available. Perlite is added at 20% to improve aeration and aid drainage. To strengthen the plug a little of clay or glue may be included in the mix – glue helps the plug retain its volume and aeration when the trays are watered.

The trays are watered by hand before sticking to make sure they are all equally moist for even rooting. After watering, holes are made in the plugs with a nail bed and then the cuttings can be stuck.

Rooting Area

High pressure fog keeps humidity at 98% and the cuttings start to root within 2 weeks. Two shade screens are used to help maintain humidity. The high pressure fog produces a very fine mist of water drops less than 1 micron in size. On warm days the high pressure fog is not enough as cuttings with a large leaf area may collapse, so there is also a low pressure fog system which operates when light levels in the greenhouse are above 700 lux. It operates in 10 s bursts and produces 80 micron droplets. This keeps the cuttings

standing on warm days and it also reduces the rooting time to less than 8 days. Because of the amount of water in the environment, the cuttings need to be removed as soon as they can be to prevent botrytis infection.

Weaning and Production

At the first signs of rooting, the cuttings are removed from the rooting area and placed in the greenhouse. Here they will be trimmed a few times (depending on customer requirements) to make side shoots. The cuttings will also be sprayed a few times for pest and disease prevention. After eight weeks the cuttings are ready for sale.

High pressure fog is used to maintain humidity at 65% to prevent leaf scorch on warm days. The pipes run along the middle of each bed with nozzles placed every four metres. The system is set to operate in pulses to provide fog for two minutes and then pause for 20 seconds so that the droplets will evaporate in the air and the cuttings stay dry.

In the summer pulsing is not necessary because if the vents are open it is difficult to maintain humidity. To keep the humidity at around 65% the shade screen is closed to 90% — if it is completely closed the temperature and humidity will rise too much. It may be possible to reduce the amount of venting, too, because if the high pressure fog is working well the temperature should not rise. If this is still not enough to maintain humidity levels then the internal air circulation system is switched off.

High pressure fog used in this way gives a very stable climate in the greenhouse by lowering the temperature by 5 to 8°C. The climate also reduces spider mite risks. A disadvantage is that algae and moss will occur more often and this will attract sciarids. To control algae an extra tank is added to the spraying machine to apply a biocide.

As the high humidity can lead to "soft" growth we use as little nitrogen fertiliser as possible and extra potassium and calcium. However we are also experimenting with the use of LED light to "harden" cuttings before sale.

Light Emitting Diode Light to Harden Cuttings

By using LEDs it is possible to tailor the light spectrum to provide specific growth responses. If a plant is given a lot of far red light it will stretch and the leaves will be thinner. When a lot of red light is given the plant will stay compact and the leaves will be thicker. When blue light is at low levels, or absent, then the leaves will be thinner and bigger. When extra blue is added the plant will make more side shoots and it will produce smaller and thicker leaves. To harden the cuttings a "light recipe" high in blue light will therefore make the leaves thicker, stronger and less vulnerable.

In the production of cuttings combinations of red and blue LEDs could be useful to control growth. And because LED lights produce almost no heat, it is possible to grow cuttings without natural light in controlled climate growth rooms on tiered benches; in this way the whole rooting process can be controlled and less production space is needed compared with growing on a single layer in a greenhouse. The main problem is that all plants have their own ideal light mix which needs to be discovered before commercial production can begin.

In Spring 2013 we undertook a small trial looking at the effects of LED lights on *Erysimum* 'Bowles Mauve'. We placed 10 plants in the greenhouse in standard light conditions; 10 plants in the greenhouse with LEDs to provide extra red light; and 10 plants were placed in a controlled environment with no daylight and LEDs were used to provide a mix of 80% red and 20% blue light.

Differences in growth were noticeable after 1 week. The plants exposed to extra red light in the greenhouse were showing some side shoots coming from the top of the plant while the plants in the controlled environment with red and blue light were developing numerous side shoots most of which were from the bottom of the plant.

After 3 weeks all plants where placed in the greenhouse to see how they would develop. The untreated plants flowered one plant at a time. Five of the plants that received the daylight with extra red treatment flowered together. The plants from the controlled environment treatment (red and blue light) all flowered at the same time and were of a

much better quality than those from the other treatments. Further trials are looking at the minimum light intensities required for these responses.