KOPPERT BIOLOGICAL SYSTEMS

Pollination and growing lights

Guidelines for application

Version 2.0 - 2018

Remco Huvermann, Edwin Muijt & Anne Mathijssen

Content

1 Introduction

During the darkest months of the year, bumblebees have trouble finding their way back to the hive. For effective orientation they need at least 28 Watt/m^2 PAR-light or 56 Watt/m^2 sunlight at the location of the hive. Depending on the type of greenhouse, this resembles about 60-70 Watt/m^2 sunlight outside.

To help them do their job, our general advice is to place the hives as high as possible (above the crop) in the greenhouse. Several placement systems can be used for this. It is also important to give the bumblebees the opportunity to work during the hours with the most daylight. Therefore, we advise using an automatic opening and closing system for the hives. By using this system and optimal placement, pollination is optimized during the winter months.

Keep in mind that growing lights produce a lot of heat, and can therefore influence the local climate in the greenhouse. This can lead to poor flower quality, which results in poor pollination. Higher temperatures could also lead to a high relative humidity (RH). If the RH rises above 80-85%, the pollen is not released from the flowers and cannot be collected by the bumblebees (no pollination).
Moreover, total light intensity, climate regime, and day and night cycle can have an impact on the overall plant and flower quality and affect flower attractivity and pollination.

1.1 Bee vision

Bumblebees see differently to humans. They need the blue, green and UV spectrum for foraging, but do not see in the red light spectrum. Conversely, humans do see in the red light spectrum but also in the green and blue light spectrum (see figure 1.1).

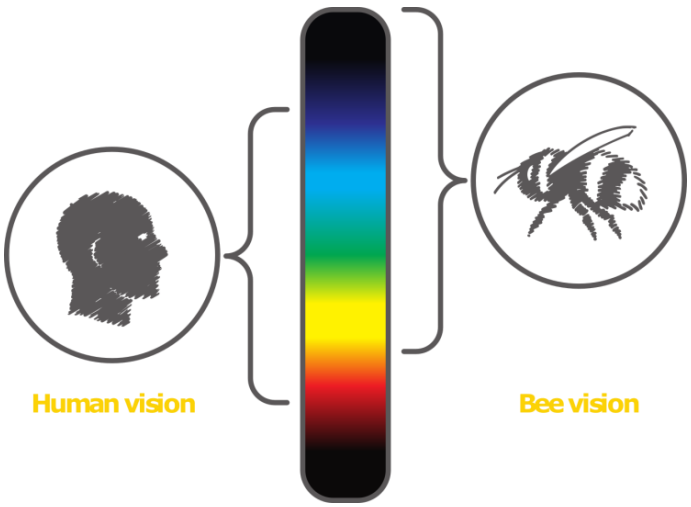
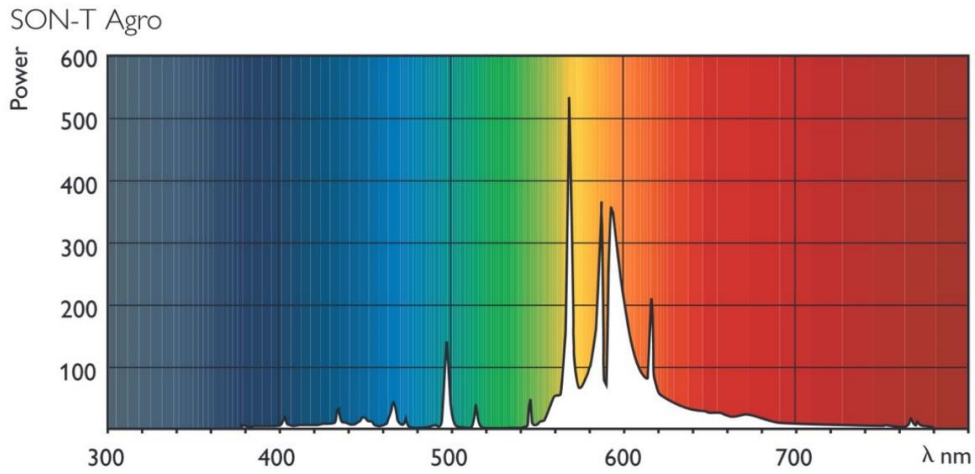


Figure 1.1 human vision VS bee vision.

In winter time, when (UV)light levels are already low, growing lights (SON-T) are often used. These lights spread a lot of light in the yellow/red light spectrum, which seriously interferes with the bees' vision (see figure 1.2).



Source: Philips
Figure 1.2 light spectrum of SON-T lamp.

On further examination, we also found that flowers use UV patterns to attract insects (bumblebees) for pollination. We then combined all this knowledge in our new bumblebee hive design for Natupol Excel (see figure 1.3 & 1.4). This hive is equipped with a blue hive door (in the visible spectrum for bumblebees) and has a special, flower shaped, UV pattern around the entrance of the hive to help the bumblebees find their way back to their own hive. Tests showed that the blue door led to 12% more direct entries of bumblebees into the hive.

Figure 1.3 UV pattern on flower.

Figure 1.4 UV pattern on Natupol Excel hive.

2 Placement of hives when using growing lights

When using growing lights, we advise to place the hives high in the greenhouse (above the crop) – especially from week 40 until week 9 (depending on the amount of daylight that is available). In the weeks 10 until 39, you can place the hives lower in the greenhouse, along the walkway under the gutter (according to Koppert's general placement advice).
From week 40 until week 9, it is also important to make sure that the bumblebee hives catch direct daylight (no filters, screens, etc.). If you do have screens in your greenhouse, for example on the sidewalls, also take the angle of the sun into account. It can happen that the direction of the sunbeams is too low and therefore doesn't reach your bumblebee hives if they are behind a sidewall screen (see figure 2.1).

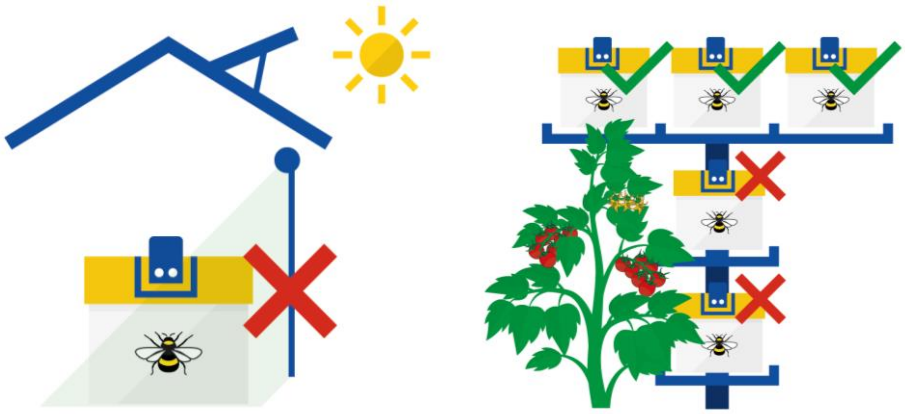


Figure 2.1 Take into account the angle of the sun and the presence of a sidewall screen for placement of hives.

To make sure bumblebees only fly around in the greenhouse at times when enough daylight is available (28 Watt/m^2 PAR light), a Wireless BeeHome system can be used. Even better is a combination of the best placement advice and automatic opening and closing of the hives, a placement system.

Flowers open approximately 1 hour after the growing lights come on and start to close 10 to 12 hours later. Switching on the growing lights before midnight, causes the flowers to close as early as 10:00 in the morning, which leaves hardly any time for the bumblebees to pollinate the flowers. Bumblebees can only do their job when there is enough daylight available to orientate themselves, which occurs late in the morning during the darkest days of the month (1 hour after sunrise), and they need at least 2 hours to pollinate all the flowers in the greenhouse (see figure 2.2).

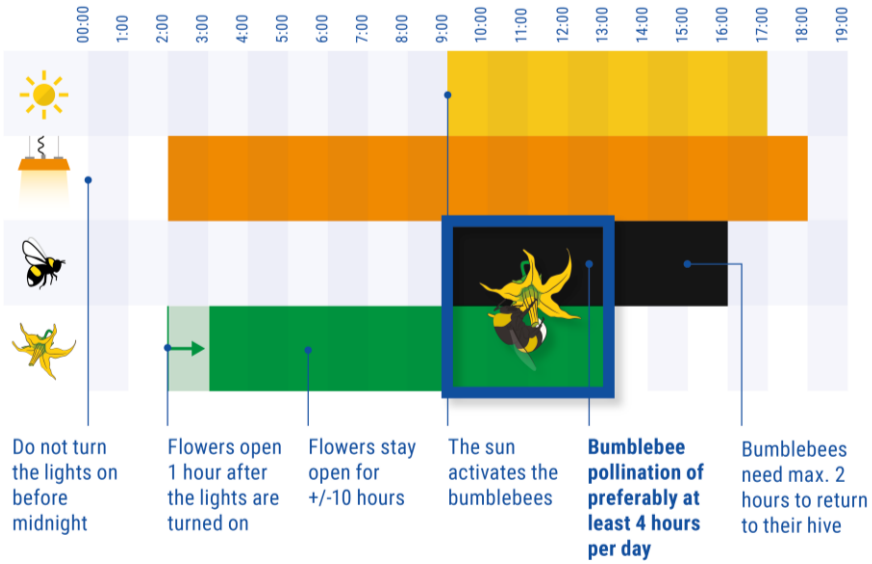


Figure 2.2 Time schedule for switching on growing lights, opening of flowers and pollination time for bumblebees.

Under optimal light conditions, it takes up to 60-90 minutes for the last foraging bumblebee to return to the hive. Under low light conditions, this time increases up to 120 minutes. Given the information above, about the time available for bumblebees to fly around, this shows that a lot of bumblebees can get lost.

Note: A bumblebee colony can lose all its foraging bees in just 2 hours if the placement advice for pollination under growing lights is not applied! Under certain conditions it may be better not to release the bumblebees on the specific day, but to open the hive the following day. Never keep a hive closed for longer than one day unless additional pollen is fed to the bees.

2.1 When to open and close the hives

In general, the hives can be opened if there is 28 watt/m^2 PAR-light, 15 minutes after sunrise or after 10:00 in the morning, depending on the system you use to control the opening or closing of the hives. The bumblebee hives should be closed 2 hours before sunset or 2 hours before the screen is closed.

If there is no light sensor available, open the hives at the following times:

The Netherlands (degree of latitude: 51-52N)

- Two weeks before and after the shortest day (mid December – mid January)
  - Open at 10:00
  - Close at 14:00
- 4 weeks before and after the shortest day (mid November – mid December)
  - Open at 9:30
  - Close at 14:30
- 8 weeks before and after the shortest day (mid October – mid November)
  - Open at 9:00 AM
  - Close at 15:00
- Outside these periods:
  - Never open earlier than 9:00
  - Never close later than 15:00

Finland (degree of latitude: 60-64N)

- Open at 11:00
- Close at 14:00

2.2 Automated opening systems for bumblebee hives

There are several placement systems on the market to automate the opening and closing of bumblebee hives like the Wireless BeeHome system and the Metazet placement system.

2.2.1 Wireless BeeHome system

When using the Wireless BeeHome system, growers can choose to let the bumblebees fly when there is enough daylight present.

It is best to place a maximum of 2 hives together. Use the styrofoam placement tool when hives are stacked. Place the hives high in the crop and clearly visible. The Koppert hive support can be used to place the hives at the correct height.

The transmitter of the Wireless BeeHome system can be controlled in different ways. Either by using a timer or by connecting the transmitter to the climate computer.

For more detailed information about the use of the Wireless BeeHome system, we refer you to the Wireless BeeHome manual on our website (www.koppert.com).

2.2.2 Metazet (horizontal) placement system

A collaboration between the Dutch companies Schenkeveld Tomaten, Jan Lelij, and Metazet/FormFlex has led to the production of a new system for the placement of bumblebee hives. This system takes into account all the advice Koppert gives for pollination under growing lights:

- High placement
- Automatic opening and closing of hives
- Good ventilation due to the space between the bumblebee hives
- Use of multiple systems spread in the greenhouse for an optimal level of pollination

Two types of frames have been designed, one for 12 bumblebee hives and one for 4 bumblebee hives. The hives are positioned with the openings in opposite directions to make sure the bumblebees find their way back to their own hive. The big frames for 12 hives are positioned above the walkway. The smaller frames for 4 hives are placed close to the sidewalls, at the end of the plant rows, to optimize pollination when daylight is at its minimum. The opening and closing system is pneumatic and is controlled by a timer or the climate computer. On a rare occasion, when air pressure drops, the system is opened automatically to prevent the bumblebees being locked in for a long time. Please contact your Koppert advisor for more information of contact details for Metazet/FormFlex.

2.2.3 Other horizontal placement systems

If you decide to use a third party horizontal placement system, please take into account the following:

- High placement
- Do the hives open when air pressure drops or electricity is shut down?
- That the ventilation of the hives is not blocked by the placement system

For more advice on using a third party placement system, please consult your Koppert advisor.

2.2.4 Vertical placement systems

Several vertical placement systems are on the market as well. These systems don't allow optimal placement of bumblebee hives. The hives that are lowest in the stack, don't receive enough daylight for the bumblebees to fly out. This can be caused by the crop covering/ shading the lowest hives. Research also showed that bumblebees tend to drift if hives are stacked (see figure 2.3). They prefer flying to the lowest hives, which causes the hives at the top of the stack to become vacant. Horizontal placement systems do not cause any drift of bumblebees.

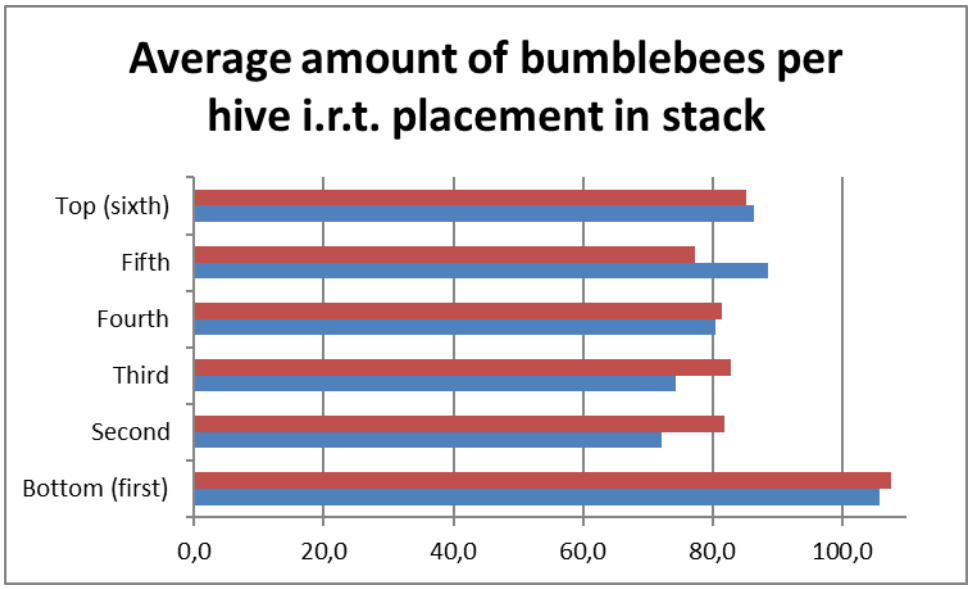


Figure 2.3 Drift in bumblebee hives caused by stacking hives.

2.3 Other influencing factors

2.3.1 Coatings, screens & filters

Coating, polycarbonate plates, screens and other light restricting filters on the sidewalls of greenhouses can have a negative influence on the orientation and activity of bumblebees. Specially when they block the early sunlight, the effect is worse. Energy saving screens are often used in greenhouses during winter. Besides their high energy saving capabilities, these screens also prevent natural daylight from penetrating into the greenhouse. Make sure the screens are open during the period of time that the bumblebees are allowed to fly (Wireless BeeHome Systems on placement systems are open). If the screens close when the bumblebees are flying around, you are likely lose a lot of bumblebees because they get locked up above the screen. Lock up the bees 90-120 minutes before the energy screens close.

2.3.2 Snowfall

Snow reflects 90% of the UV-light. It disturbs the orientation of bumblebees while it falls and when it covers the greenhouse. Keep a close eye on pollination during snowfall and introduce extra bumblebee hives if necessary or temporarily carry out hand pollination. If possible, remove the snow from the roof of the greenhouse.