NSW Agriculture

Light in the greenhouse

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Plant growth is influenced by both the quality and intensity of light reaching the leaves.

MEASURING LIGHT

If you have ever tried to look up light measurements you would probably have gasped at the multitude of terms used, including footcandles, lux and lumens, watts per square metre, megajoules and even micromoles per square metre per second!

Essentially, for the greenhouse, light may be measured in terms of its intensity (lux) or the number of photons reaching a surface (photon flux density). The metric unit of light intensity is the lumen and the term lux refers to the number of lumens per square metre of surface area. A footcandle is the imperial unit and one footcandle is roughly equivalent to 10 lux.

In horticulture we are more interested in the number of photons reaching a surface. Photons are basically packets of energy which make up a stream of light. The number of photons trapped by a leaf determines the level of photosynthesis and therefore the amount of plant growth.

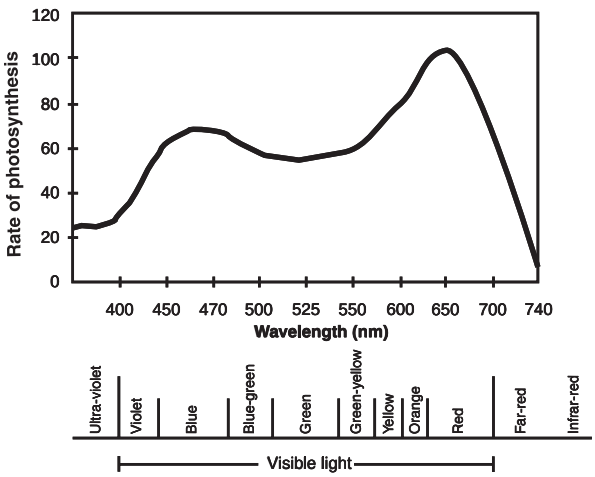
Photon flux density is measured as mol.m-2.s-1 or moles per square metre per second. For convenience, since a mol is a very large number, photon density is usually measured in micromoles per square metre per second(µ mol). (A mol is a constant used in science for a range of measurements.)

USEABLE ENERGY

Light energy is used by the plant in the process known as photosynthesis to manufacture carbohydrates. These carbohydrates are then used to produce other compounds needed by the plant. Respiration is the process in which the trapped solar energy is later released.

PAR stands for photosynthetically active radiation. This is the part of the light spectrum used for photosynthesis and plant growth. PAR includes wavelengths from 400-700 nanometres (nm). This band represents almost all of the visible light (i.e., the light we can see).

The rate of photosynthesis peaks (see graph below) in most plants around 450 nm (blue light) and 650 nm (red light). Plants require a reasonably balanced spectrum in this range. Red light alone produces soft growth and long internodes. Blue light alone results in short, hard plants.



LIGHT TRANSMISSION

The amount of light entering a greenhouse is influenced by the:

- orientation of the structure
- materials used in construction and covers
- shape of the roof.

The greenhouse should be positioned north-south to provide more uniform light and reduce the shading effect of the support structure. The support

structure must also be minimised to avoid shading. Metals make good structural material because of their strength which means narrower trusses and purlins can be used. A typical greenhouse frame can reduce light transmission by more than 10%. The type of covering material will also influence the level of light in the greenhouse.

Finally the shape of the roof will impact on how much light enters the greenhouse. For example, a flat roof will limit the amount of light while a curved roof provides the greatest annual light transmission.

QUALITY OF LIGHT

A balance of light across the PAR range is preferable and when providing shade, reduced intensity across the full spectrum is assumed to be better than reducing particular colour wavelengths. There is considerable research in the area of light spectrum modification for improved plant growth.

Diffuse light is better than direct light because it is able to reach the lower parts of the canopy (less shadowing) and it will not cause sunburn. Irrespective of whether the light is direct or diffuse, it must be of sufficient intensity (lux).

The selected covering material may also be used to increase the amount of diffuse light. A textured surface on glass, for example, can increase the proportion of diffuse light without significantly reducing the total level of light transmitted.

On a cloudy day, the majority of the light will be diffuse. On the Central Coast of NSW, the warmer months are characterised by a greater number of cloudy days than the cooler months. This is an ideal situation for greenhouse production.

LIGHT INTENSITY

Plants have an optimal intensity of light. This is the point at which the process of photosynthesis is maximised and plant growth is greatest. If the level of light is less, growth is reduced. In chrysanthemums, a light level of 4000 lux is just enough for the rate of photosynthesis to equal the rate of respiration. This is called the light compensation point. At this point, there is no net growth, but the plant can survive.

The point where an increase in light intensity will not increase photosynthesis any more is called light saturation. In many crops, an upper leaf would be saturated at around 32,000 lux. However, because of shadowing of lower leaves, light levels of around 100,000 lux might be necessary for the whole plant to become light saturated. In a greenhouse, the intensity of light can range from as much as 130,000 lux on a clear summer day to less than 3,000 lux on overcast winter days.

LEVEL OF LIGHT REQUIRED BY CROPS

Different crops prefer different light levels. While many indoor plants will tolerate light intensities as low as 25,000 to 30,000 lux, the amount of light reaching the majority of crops should be maximised. Crops such as rose and carnation prefer higher light conditions and easily tolerate full summer sun as do tomatoes and cucumbers. A plant's natural environment is a good indicator of how much light a plant prefers.

WHAT TO AIM FOR IN THE GREENHOUSE

Maintaining an optimum level of light for the growing crop will generally mean maximising light intensity during winter, and even for crops that can handle full sun, reducing radiation in summer to reduce the accompanying heat which would otherwise stress the plant. (Fogging and ventilation are also important methods of greenhouse cooling.)

Low light slows growth and increases the cost of production but excessive light intensity can damage some plants and/or fruit. Light is increased by minimising objects above the plants including frames, pipes, lights and other equipment. The level of radiation entering a greenhouse can be reduced in summer through the use of greenhouse paint (whitewash) or suspending shade cloth above the structure. There are also a variety of screens available to reduce the level of radiation in order to reduce heat and/or light.

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