

Light in the Greenhouse: How Much is Enough?

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Most of us know that green plants need light for photosynthesis, growth, and development. As important as it is, however, that is not all there is to the role of light in plant growth and development. Plants respond in various ways to the intensity and duration of light. Let's look at each of the ways that light affects plant growth.

PHOTOSYNTHESIS

Photosynthesis is defined as the process in green plants by which carbohydrates are synthesized from carbon dioxide and water using light as an energy source. It is essentially an energy transfer reaction.

The carbohydrate constitutes an energy source that is stored in the plant and can be moved to the roots of the plant, the fruit of the plant or any place in the plant where growth is occurring. It is used as a building block in growth and to provide energy to the growth or other operation in the plant.

Photosynthesis takes place only in the green part of the plant and only when there is light and the other elements — water and carbon dioxide — needed to facilitate the process. An ongoing supply of both water and carbon dioxide are needed at the site on the leaf cells where photosynthesis occurs.

During cold weather carbon dioxide levels in the greenhouse can drop as a result of photosynthesizing plants unless the level is replenished by air exchange, and possibly even carbon dioxide supplementation. Many greenhouse growers, including commercial growers, have starved their plants for carbon dioxide in the attempt to conserve heat by limiting or eliminating air exchange in the greenhouse. Up to two full air exchanges an hour have been recommended for greenhouses to keep the plants and the equipment functioning properly. However, some growers have found that half an air exchange an hour has provided a satisfactory plant environment in their greenhouse. A full air exchange consists of replacing all of the greenhouse air with outside air, while a half air exchange consists of exchanging only half the air in the greenhouse. When the outside air being circulated in is cold winter air, it must be heated. Although the sun will help with heating the greenhouse some of the time, the greenhouse heating system will bear most of the heating load.

LIGHT MEASUREMENT

Several types of units of light measurement will be mentioned in this article. However, due to the complexity of this level of detail of quantifying light, specific units will be avoided in the overall discussion on light.

Some light units are based on the human eye's perception of light. Footcandles, lux, and lumens are in this category.

Photosynthetic Active Radiation (PAR) is a term that refers to the amount of light within the 400- to 700-nanometer wavelength range. This is the range of light within the visible light range that is used by plants for photosynthesis. Since plant photosynthesis is the main use of supplemental light in the greenhouse, light sources are often rated on the amount of Photosynthetic Active Radiation delivered to the plant surface.

Two groups of light measurement exist. One consists of the quantification of the light emitted from a light-emitting unit or bulb — a measurement of the light given off by the source. The other group of measurements quantifies the amount of light reaching a surface. This is considered by many people to be the important measurement for light because it affects plants and plant growth. Commonly used units include micromols or, more precisely, micromols per square meter per second, and watts per square meter.

Accumulated light within the greenhouse is often measured over the period of a day. Some commercial growers will supplement the natural light received by the plants to bring the total light received by the plants up to a specified level. A commonly used unit for this measurement is moles per square meter per day.

The decrease in light reaching a surface is proportional to the square of the distance between the light source and the surface. Put simply, light decreases very rapidly as the distance from the light source increases. This is a very important factor to bear in mind when working with supplemental light sources in the greenhouse. A more powerful light will need to be farther away from the plants in order to deliver light to a larger area. The height of the greenhouse may or may not allow for this.

HOW MUCH LIGHT IS NEEDED BY PLANTS?

Young plants need less light than do older plants. Seedlings can be started successfully under either low-level natural light or artificial light. Very shortly after the seedlings have germinated, and even before the first true leaf is visible, the plant starts responding to light levels. If the seedling is not getting enough light, the cells in the plant stem will elongate, pushing the cotyledons and the developing first true leaf up to seek more light. As a result, a thin-stemmed, weak plant is produced. If the plant survives, the stem will never thicken to equal the normal size at the base of the plant.

If there is enough light for the young seedlings while the first true leaf is developing and beginning to expand, the base of the stem will remain compact and the cotyledons will not rise to an excessive height. However, if the leaves from surrounding plants start to overlap one another as growth continues, stem-stretching will occur because the leaves will not get enough light. The light intensity may be adequate for the plant according to what is required, but the individual leaves are not getting the required light due to shading by the leaves of adjacent plants. To avoid this, plants need adequate spacing from each other to get adequate light and develop properly.

Plant spacing depends on the plant itself and the way the plant is trained. Indeterminate tomato plants in a greenhouse should have a minimum of four square feet (0.36 square metres) per plant. This includes aisle spacing. Closer plant spacing in a large plant population will reduce the fruit size. More plants in a given space may produce more fruit, but the total weight of the fruit may be no more or even less than that achieved by wider spacing.

As plants grow and increase the number of leaves, the need for light increases. Part of this is probably a result of the newer leaves on the plant tending to shade the older leaves at the lower levels. Providing higher light intensity as the plant grows ensures that more light will reach some of the older leaves on the plant.

Plants growing vegetatively need less light than they will need when they transition into the reproductive or flowering and fruiting phase of growth. Greenhouse plants may be moving into the reproductive phase at the time of year when days are shorter and natural light is more limited. For example, by the end of October, tomato plants in greenhouses across most of North America stop receiving enough natural light to support full tomato production. Tomato plants grown during this time period will decrease their production to one third or less without the addition of supplemental light.

Lettuce and many herbs are grown for their vegetative plant parts and require less light because they are kept in the vegetative growth stage. Lettuce can still be grown successfully in a greenhouse even when natural light has dropped to the point where tomato plants should be removed. However, lettuce growth will slow when light levels are low during the winter months.

Hanging plants in pots or baskets in the greenhouse above small plants will reduce the light getting to the plants below. This usually should not be done in the hobby greenhouse unless at least some of the plants will be moved outside within a short time. This type of “plant stacking” is often done in commercial greenhouses where the young plants are the saleable product and they are moved out before the light demands of the plant exceed the amount getting to them.

CAN PLANTS GET TOO MUCH LIGHT?

Plants cannot get too much light, but they can get too much of the heat energy that comes with the light. Photosynthesis and other plant growth processes will shut down when the environmental and tissue temperature gets high enough that all the water taken up by the plant is used to cool the plant tissue. Shading should be used to cool the greenhouse when all other practical cooling techniques are being employed and more cooling is needed.

Once all the other temperature reduction measures such as air movement and evaporative cooling are employed, the only remaining course of action to further cool the greenhouse is the use of shading. White or silver-coloured shade cloth should be used on the outside of hobby greenhouses because the light colours reflect the heat. Black or green shade cloth absorbs the heat and then radiates it down onto the plants. It is best to place the shade material on the outside of the hobby greenhouse because there is usually no room to put it inside.

WHAT QUALITY OF LIGHT IS NEEDED FOR PLANT GROWTH?

Most of the light used by plants is in the visible light range. Red and blue light are the wavelengths of light most extensively used in plant photosynthesis. They are components of white light or sunlight. Various artificial light sources have different colour mixtures that may or may not meet the photosynthetic needs of the plant. Next, we will discuss some of the characteristics of artificial light sources.

High pressure sodium light produce light mainly in the yellow and red end of the light spectrum. Much of the light generated by high-pressure sodium lighting is usable for plant photosynthesis. However, other processes in the plant, including the control of cell elongation to seek light, react to the presence of light in the blue end of the visible light spectrum. High-pressure sodium lights can be used to extend the photosynthetic day for plants in a greenhouse when enough natural light is received by the plants to keep them growing normally. They are more efficient in converting electricity to light energy than are metal halide lights.

Metal halide lights produce a more desirable light spectrum than do high-pressure sodium lights. In a basement or garage setting, plants would need to be lighted with metal halide lights so that they would get the range of light within the light spectrum to photosynthesize, grow, and develop properly.

HOW LONG DOES THE LIGHT NEED TO BE SHINING?

Light intensity and duration must be enough to provide for the photosynthesis needed to keep the plant growing and producing. Not all kinds of plants have the same needs. Some plants respond to the length of the day or, more accurately, the length of the night or dark period.

Some plants are called “long day” plants because they will go into the reproductive fruiting phase of plant growth when the day is long and the night is a certain length or shorter. That critical length will vary from plant to plant and sometimes from one cultivar to another within a plant species. Other plants are “short day” plants that go into the reproductive plant growth phase when the night length is a critical length or longer. For example, many herbs are “short day,” and will often start going into flower in the fall as the days get shorter and the night gets longer. To keep them growing vegetatively, as is desirable for herbs, light must be provided to extend the day length or to break up the long night with a period of light. The intensity of the light does not need to be very great to bring about a change in the plant’s response to day length. Usually, if there is enough light for someone who wears bifocals to read this article while it is held next to the plant, the light is sufficient to influence the response in the plant.

Some plants are not triggered by day length, or length of the dark period, to go into the reproductive growth stage. Tomato plants will simply begin to flower after a certain amount of vegetative growth has occurred. Tomato plants should have six to eight hours of darkness to grow properly. Other plant functions take place when photosynthesis is not occurring. When photosynthesis occurs, it takes priority over some other activities in the plant.

Light and temperature combine to bring about a reproductive growth response in lettuce. A combination of long days (short nights) and high temperatures will make lettuce more likely to “bolt” or go into the flowering phase. That makes it bitter and inedible. Lights can be used to extend the days to increase lettuce growth when the temperatures in the greenhouse can be kept below the mid-70s °F (~21°C). When the temperature rises into the 80s °F (~27°C), however, the light supplementation should be stopped to minimize the chance of the lettuce bolting.

Light is a critical component to photosynthesis and proper plant growth. The need for light can differ from one plant species to another, and even from one cultivar to another. The successful greenhouse grower will be mindful of the various crops being grown in the greenhouse and their individual lighting needs, and will ensure plants have sufficient spacing to receive the available light. All other plant needs can be met in the greenhouse, but unless light is carefully evaluated and managed, plants will not grow properly and yields will be lower or fail entirely.

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