Technical Information Bulletin

Light and Plants

Standard and Wide Spectrum SYLVANIA GRO-LUX®
Fluorescent Lamps

SYLVANIA

Light Sources

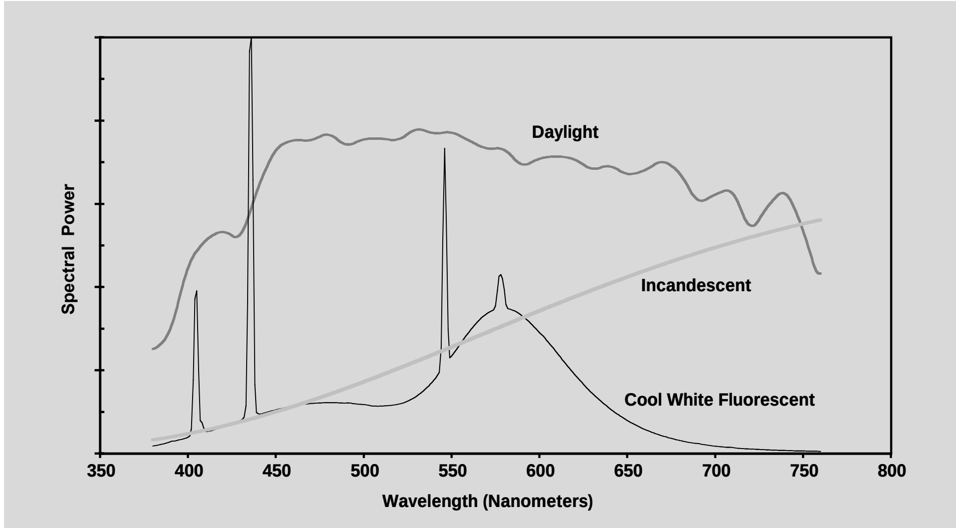

Figure 3. Spectral Energy Distribution for Daylight, Incandescent Light, and Cool White Fluorescent Light

Different sources of light produce different amounts of light at different wavelengths. For any particular source of light, it is possible to chart the quantity of light in each wavelength that is emitted by the light source. This chart is called a spectral power distribution (SPD) curve. *Figure 3* (right) shows SPD curves for three different light sources: the sun, a cool-white fluorescent lamp, and an incandescent lamp. The only difference between daylight and electric light is the amount of energy emitted at each wavelength. The light energy itself is fundamentally the same, and each wavelength has the same effect on plants regardless of the source.

So how can an electric light, which produces only some of the wavelengths contained in daylight, work as well as daylight to help plants grow? The answer lies in research that shows exactly which wavelengths the plants use, and in new lamps such as the GRO-LUX® that provide the wavelengths plants need. In fact, OSRAM SYLVANIA has developed two different GRO-LUX lamps, Regular and Wide Spectrum, to help you solve different issues in plant growth.

The following sections explain the plant activities, such as photosynthesis, for which plants require certain wavelengths of light. But first, let's take a look at some of the other differences between light sources.

Efficiency: Fluorescent lamps (including GRO-LUX lamps) are about four times as efficient as incandescent lamps. This means that a 20-watt fluorescent lamp produces about as much light as an 80-watt incandescent lamp, so it requires only one-fourth the electricity.

Temperature: Because incandescent lamps convert much of that extra wattage into heat, they are much hotter, and cannot be placed too close to plants. The cooler fluorescent lamps can be placed closer to the plants, thereby providing even more than four times the light on plants for the same wattage.

Life and Cost: Although they cost a bit more to purchase, fluorescent lamps last up to 15 times as long as incandescent lamps, so they are actually less expensive in the long run.

Light Distribution: Unless they are placed very close together, incandescent lights create "hot spots" of bright light with darker areas in between, resulting in uneven amounts of energy reaching your plants. Fluorescent lamps provide even light distribution along their length (from eighteen inches to four feet long), resulting in an evenly bright environment for your plants.

How Light Affects Plants

Plants use the energy from light for more than photosynthesis. The effect of light is still one of the most complicated questions in plant study today. The four aspects of plant growth most affected by light are:

- photosynthesis — converting light, air and water into carbohydrates and oxygen
- chlorophyll synthesis — building the plant cells that perform photosynthesis
- photoperiod — sensitivity to the length of day
- phototropism — movement toward a light source.

They are discussed in detail in the following sections.

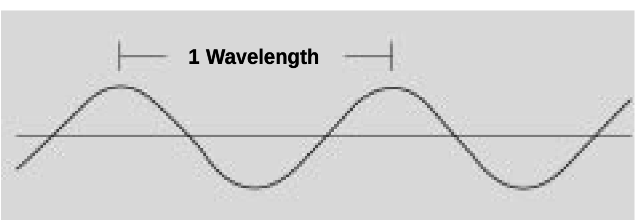

Figure 1. Example of a Wave

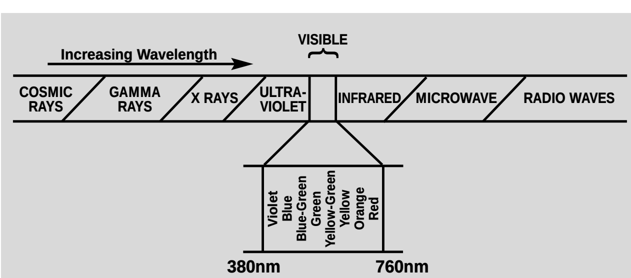

Figure 2. The Electromagnetic Spectrum

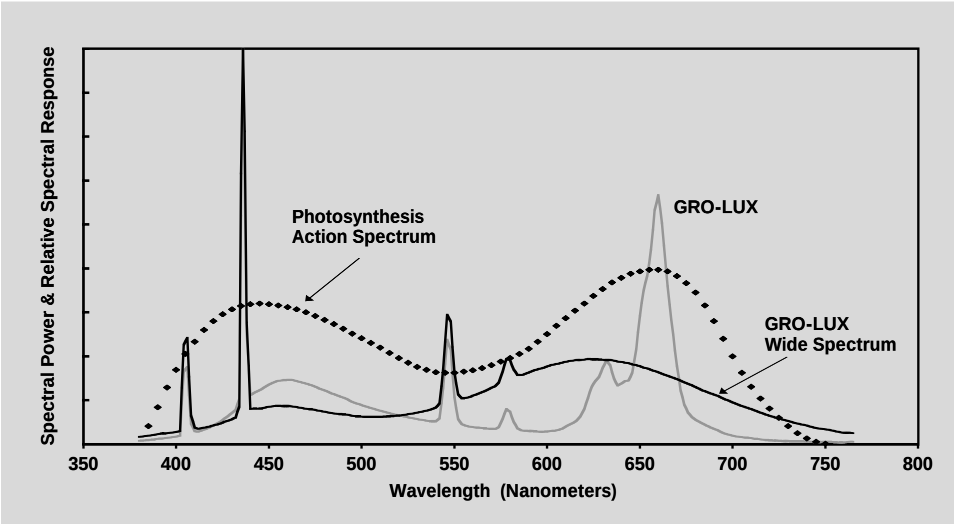

Figure 4. Photosynthesis and GRO-LUX Lamps

Almost all life on our planet depends on photosynthesis. Plants produce food for themselves and others when they use the energy from light to convert carbon dioxide and water into carbohydrates and oxygen. The substance that performs photosynthesis is called chlorophyll. Studies have shown that chlorophyll absorbs blue (short wavelength) and red (long wavelength) light for photosynthesis, as shown in *Figure 4 (*above). However, chlorophyll doesn't absorb green (medium wavelength) light. It reflects the green light, which is why chlorophyll – and therefore most leaves – look green.

Incandescent lamps provide red light but very little blue light, while cool-white fluorescent lamps provide blue, yellow, and green light but very little red light. As *Figure 4 (*above) shows, both the regular and the wide-spectrum GRO-LUX lamps provide blue and red light in the proportions needed for photosynthesis.

Different plants require different amounts of light in order to grow their best. For example, most vegetables require full sunlight, while most ferns grow best with indirect light. Plants are referred to as either high-energy or low-energy plants, depending on the intensity of light they need. The following table lists some common high-energy and low-energy plants:

For low-energy plants (which includes most houseplants), standard GRO-LUX lamps provide the right balance of wavelengths. However, high-energy plants seem to require more light in the far-red portion of the spectrum, and grow better if half of the lamps are standard GRO-LUX and half are wide-spectrum GRO-LUX. You could supplement the standard GRO-LUX lamps by using incandescent lamps to provide 10-20% of the total wattage, but this requires two different types of fixtures and makes it more difficult to light the plants evenly.

High-energy plants also require more light than low-energy plants. An easy way to figure out how much light energy your plants need is to find how many watts of fluorescent light they need per square foot, and use that number to determine the number of lamps you need.

For example, assume that your plants have no sunlight at all, your lamps are 12-15 inches above your plants, and that you are using 4-foot fluorescent lamps to light a plant shelf that is 2 feet wide and 4 feet long (8 square feet).

Low-energy plants require about 15 lamp watts per square foot, so you would need 120 watts, or three 40-watt fluorescent lamps. High-energy plants require at least 20 lamp watts per square foot, so you would need at least 160 watts, or four 40-watt fluorescent lamps. You can accomplish this by adding more lamps, adding a reflector above the lamps to direct more of the light toward the plants, or moving the lamps closer to the plants. Germinating seeds or cuttings being rooted only require about 10 lamp watts per square foot, but the lamps should be closer — only about 6-8 inches above the soil or tops of the cuttings.

If your plants receive some natural sunlight, you can decrease the amount of light from the lamps proportionately.

Note that these recommendations for watts per square foot are for fluorescent lamps only. If you are using incandescent lamps, you need four times as many watts per square foot.

Low-energy Plants	High-energy Plants
Aglaonema (Chinese evergreen)	Aglaonema roebelini (Chinese evergreen)
Aspidistra (Iron plant)	Anthurium hybrids
Aucuba	Begonia metallica
Dieffenbachia (Dumb cane)	Begonia semperfiorens
Dracaena	Begonia rex
Nephthvtis (Syngonium)	Bromeliads
Pandanus Vietchi (Screwpine)	Cissus (Grape ivy)
Philodendron Oxycardium	Calceolaria
Philodendron pertusum (Monstera)	Calorophytum (Spider plant)
Sansevieria (Snakeplant)	Coleus
	Crassulla (Jade plant)
	Fern – Bird's nest
	Fern – Holly
	Ficus (Rubber plant)
	Kentia fosteriana (Kentia palm)
	Kalanchoe
	Peperomia
	Philodendrons other than oxy cardium and pertusum
	Pilea cadieri (Aluminum plant)
	Saintpaulia species (African violet)
	Schefflera
	Scindapsus aureus (Photos)
	Sinningia species (Gloxinia)

Chlorophyll Synthesis

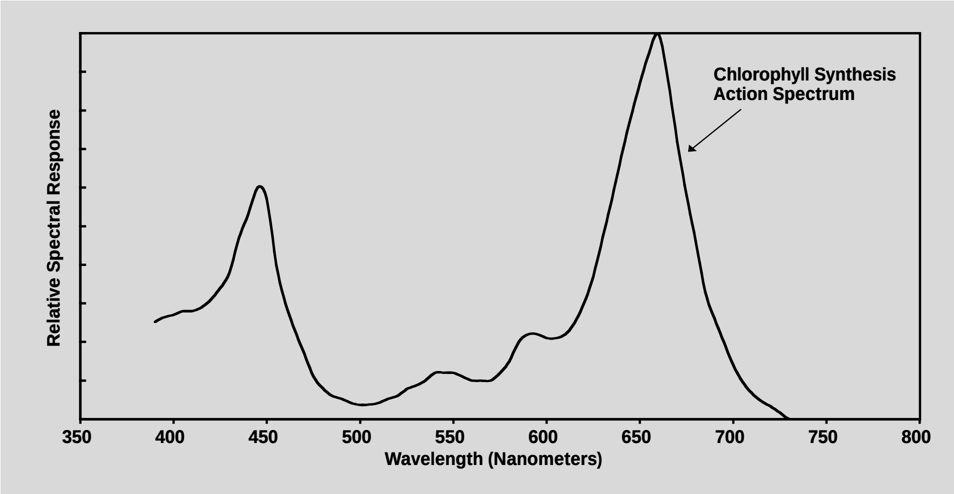

Figure 5. Action Spectrum for Chlorophyll Synthesis

Plants also need energy to produce chlorophyll itself. Like photosynthesis, chlorophyll synthesis occurs whenever the plant has enough light. *Figure 5* (above) shows the wavelengths plants use to produce chlorophyll. Notice that the curves for chlorophyll synthesis and photosynthesis are very similar to the light produced by standard GRO-LUX lamps.

Photoperiod

All plants need several hours of darkness each day. Just as light triggers activities like photosynthesis and chlorophyll synthesis, darkness triggers other activities, such as flowering. The term photoperiod refers to the length of the day for a plant.

Plants that bloom in the winter, such as Christmas cactus, poinsettias, gardenias, and chrysanthemums, don't bloom unless the nights are longer than the days. They are referred to as long-night plants. For the most sensitive long-night plants, even one minute of bright light during the night is enough to prevent them from blooming. In general, long-night plants need a maximum of 10-13 hours of light per day to flower.

Plants that typically bloom during the summer don't bloom unless the nights are shorter than the days, so they are called short-night plants. Short-night plants include china asters, carnations, nasturtiums, and most grains, vegetables, and annuals. Short-night plants need 14-18 hours of light per day in order to flower.

Other plants bloom regardless of the length of the photoperiod, so they are called night-neutral plants. These include roses, carnations, geraniums, and many household plants such as African violets, gloxinias and begonias. Many of these plants are sensitive to temperature variations, and bloom when the nights are cooler than the days. For these plants, turning off the lights at night might still encourage them to bloom because it's cooler with the lights off.

For early growth and development, plants need the opposite photoperiod: young long-night plants should have long days for the first month or two to encourage full growth before blooming, while young short night plants should have short days.

By installing an inexpensive automatic timer, you can make sure that the plants receive the amount of light that they need and that they bloom when you want them to. For example, if you live in the northern U.S., you might find that a Christmas cactus next to a window blooms too early. You can add a light above the cactus and use a timer to keep it on for an hour or two after sunset each day in the early fall, then gradually taper off the extra light to encourage the plant to start blooming. You will need to experiment to determine how much extra light to provide each day and when to start reducing it for your part of the country.

Phototropism

Sunflowers are so named because they turn their heads each day to follow the sun as it moves across the sky. Most plants react similarly to light, although not always as obviously. This movement of plants towards (or sometimes away from) light is called phototropism. Phototropism can cause plants to lean or grow unevenly if their light is uneven or comes only from one side of the plant (such as a window). Some plants are so sensitive that they respond phototropically to light having an intensity about as bright as full moonlight.

As with photosynthesis and chlorophyll synthesis, phototropic responses depend on certain wavelengths of light. The most effective wavelengths range from 440 to 480 nanometers (the blue and blue-green region of the spectrum). Ultraviolet light produces about 25% of the effect caused by blue light. Red light doesn't trigger phototropism at all, and green light produces only slight effects.

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