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The Importance of Light for Orchid Growth

by Dr. Carl L. Withner, Canadian Orchid Congress

As a result of photosynthesis, plants manufacture sugars and starches and many other compounds in their green tissues during the day. These accumulate and are translocated about the plant, particularly at night, and are transformed by biochemical processes into all other plant constituents that are necessary for formation of new tissues and growth. The energy for the photosynthesis comes from the sunlight. The energy for maintenance and growth comes from the breaking down of sugars by the process called respiration. Respiration for maintenance occurs constantly in all cells, whether growth is occurring or not; whether they are green and in the light or not.

At the so-called “compensation point”, only enough sugar is produced during daylight with its particular temperature and light intensity and duration, to provide the amount of energy (sugars) for maintaining the plant in a living conditions Respiration just balances photosynthesis. There is nothing left as a reserve, or for the formation of next cells and tissue, or to produce flowers or seeds. The problem is thus to increase photosynthesis to a point where it will not only provide for maintenance respiration but will also provide a reserve to be stored that will not be respired and will enable maximum growth to occur. Most growth, incidentally, takes place at night.

An easy way of aiding the growth process is to have lower temperatures at night than during the day. This slows down the rate at which reserves are respired by plant parts and conserves them for growth function instead of just burning them up to form carbon dioxide and water. Lowering the temperature slows down respiration faster than it slows down growth. For similar reasons, when weather is dull and light is at a premium, it is possible to help the plants along by lowering even the day temperatures at which they are grown. Since photosynthesis is first of all a photochemical process not immediately affected by temperature, the decrease in temperature preferentially influences respiration and provides a more favorable balance for growth and reproductive processes. Respiration, in other words, is more affected by temperature than growth or photosynthesis and this difference may be put to advantage.

A question arises about the optimal temperatures to use and the best light intensities and durations to give the plants. Trial and error can teach you a lot, but there have been a few studies on orchids that can give you guidance. These were mostly done in air-conditioned greenhouses at Cal Tech, under the supervision of Professor Frits Went. They are written up in Went’s book, “The Experimental Control of Plant Growth”. Most plants, including orchids, may be divided into sun or shade plants, according to the conditions under which they grow best. Phalaenopsis and Paphiopedilum are shade plants with optimal light intensities of 700-750 footcandles saturating the leaves; whereas Cattleya or Cymbidium are sun plants requiring about 1000 fc. To produce full saturation of leaves. And with sufficient airconditioning the Cattleya may be grown in “full” sunlight (12-15,000 fc.) if there is efficient cooling of the leaf tissues.

But various factors complicate the situation. Those fc. values refer only to individual leaves under ideal conditions. Greenhouse conditions may make the actual required intensities greater. The optimum light intensity may only be present for a short while each day, and upper leaves or crowded leaves can shade those lower down or to the side. The leaf position is also of importance - horizontally placed leaves receive little morning or evening light, but will receive fuller intensities at noontime; vertically, if leaves face east or west, about 4,000 fc. All day; or facing south, leaves will receive the available light all day in summer, relatively higher intensities around noon in winter. The ideal situation, of course, is to light-saturate all of the photosynthetic tissue of each plant for the optimal length of time. Practical experience long ago indicated that staging, or hanging plants near the glass, as well as orienting the greenhouse in a NS direction had merit.

Went states, "...the more light a plant receives, the more layers of leaves it can maintain... one of the main differences between the photosynthesis of shade and sun plants is that sun plants produce more layers of leaves, whereas shade plants have most of their leaves in one layer. Another possibility is that shade plants have a larger proportion of their leaf surface to total weight of the plant than sun plants, which would mean also that they have a smaller loss of weight at night by respiration than plants with a larger proportion of non-green tissue..." Naturally, the more tissue a plant possesses, the more respiration that must go on to maintain the tissues. The most efficient plant is the one with the greatest photosynthetic ability coupled with the smallest bulk, and that mostly in leaf surface.

The effectiveness of different colors of light is of direct importance only when artificial light is being used. Under artificial conditions best growth has been obtained by using a combination of red (6-7,000 angstroms) and blue (4-5,000 angstroms) fluorescent bulbs. This combination was much better than growth with "warm white" bulbs which were next in effectiveness. The "daylight" bulbs were poorer yet. Results, even so, were always improved when 5-10% of the visible radiation came from incandescent bulbs used along with the fluorescents. This latter effect is not exactly understood. Ultraviolet and infrared radiations are without beneficial effect on plant growth and are not required for normal development. The whole visible spectrum, with the exception of green light, does however, seem to be necessary for normal growth and reproduction. Greenhouse grown plants, supplemented with lights, can be superior to ordinary plants. They may have better light intensities for longer periods of time, especially in poor cloudy weather.

"When growing conditions are poor, for instance, in low light intensities, the actively growing new shoot completely inhibits flower development on the mother shoot, but in high light intensity, both flower development and new growth can occur on the same shoot. This makes it seem as if there is active competition for photosynthesis by vegetative growth and developing flowers. When photosynthesis exceeds the demand for carbohydrates by storage organs or growing shoots, the excess sugar is excreted as liquid droplets on lower-stalks, flower-sheaths, and leaf-blades..." In addition, leaves may also develop a red color on the back or along the veins or margins.

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Seedlings of Cattleya and Cymbidium, in their younger stages are usually grown as shade plants with conditions similar to those for Phalaenopsis or Paphiopedilum. Perhaps it would pay to reread Hager's article in the February 1954 *AOS Bulletin*. By taking maximum advantage of the Cattleya growth possibilities, he was able to raise seedlings to flower in 21/2 years! He used high light intensities up to 4,000 foot-candles, 16-hour days, and a continued high level of humidity, water and nutrients.

A thorough discussion of light also raises the question of an ideal greenhouse shading material - a pigment reflecting heat rays and all those but the reds and blues mentioned above. How could this most effectively be produced?

Note: The late Dr. Carl L. Withner wrote this article in 1959 and a version of it was published in the American Orchid Society Bulletin in March 1964 (33(3) pp. 216-220, and it was reprinted in the April 2001 Canadian Orchid Congress newsletter, a great searchable source of orchid information.