COLORADO GREENHOUSE GROWERS ASSOCIATION, INC.

Research Bulletin

Bulletin 370
Edited by David E. Hartley
April 1981

INDOOR PLANT ACCLIMATIZATION — LIGHT[1]

V.J. Miller[2]

"If I should live to be the last leaf upon the tree" wrote Oliver Wendell Holmes." With apologies to Oliver, an excellent botanical poet and physician, such a leaf would undoubtedly be an acclimatized one. Acclimatization is a new technique for creating longer-lived foliage on indoor landscape plants. Whether a plant lives or dies after being installed in a new home may depend far more on its previous environment than on the color of its new owner's thumb.

Gardeners who have bought and carefully installed an attractive Weeping fig or similar plant, only to have most of the leaves drop, know the feelings of impotence which accompany this. Nothing which they try stops the falling of the leaves. Even though the tree lives, as it generally does if in a reasonably good environment, it is unsightly for many months before it recovers.

Factual information has been practically nonexistent so far as indoor plant behavior is concerned. Hundreds of publications list requirements for success, but these invariably are based on a very limited observation. Serious scientific study on various facets of this behavior has been initiated by various universities only recently, commencing about 1970.

Widespread interest in this is demonstrated by the geographic diversity of published research. Included are C.A. Conover and R.T. Poole of the University of Florida, R.G. Pass and D.E. Hartley of Colorado State University, W.C. Fonteno and E.L. McWilliams of Texas A & M University, J. Vlahos and J.W. Boodley of Cornell University, and A. Kofranek of the University of California. This certainly isn't inclusive of the work being done, either.

Everette Conklin, an interior plantscaper in New York, noticed that plants kept in rather heavy shade for several weeks before being utilized in buildings survived that drastic move in much better condition than did those plants moved in directly from the growing areas. This, as well as similar observations by others, led to investigations as to why this should be, and what growers might do to produce plants acclimatized for indoor conditions.

In Florida, large trees were grown either in full sunlight or in light shade. The Florida researchers took plants which had been growing in strong light and placed them under shade clothes giving them varying degrees of shade. Plants were removed from these growing areas and placed under indoor conditions after periods varying from 5 to 15 weeks. They were left here for several months while the leaf drop which occurred was measured.

Weeping fig trees were found to drop only half as many leaves after being acclimatized only 5 weeks under 80% shade as did their counterparts which had grown with no shade. Ten or 15 weeks of shade reduced leaf drop even more, but not proportionately.

This proved to be the basic tool for acclimatizing plants. The shade period reduced leaf drop greatly but it was still excessive. Plants were then grown entirely under shade to market size. These proved to be fully acclimatized and behaved satisfactorily when moved indoors. A double-meaning slogan was then adopted of: "Growing them right from the start."

Trunk diameter becomes greater under intense light than under shade. Growers producing large trees often want more massive trunks, so they grow them in strong light. Such trees were found to need a minimum of 90 days in heavy shade for acclimatization, a full year being better. Only when all of the sun leaves have been replaced with shade leaves is acclimatization complete.

[1]Reprinted from Florida Foliage. April 1981
[2]Professor of Horticulture, Arizona State University; on leave at the University of Florida Agricultural Research Center-Apopka.

This bulletin is published in cooperation with Colorado State University Experiment Station and Cooperative Extension Service. The information given here is supplied with the understanding that no product discrimination is intended and that no endorsement of a product is implied.

Physically there is little difference between leaves which develop on plants in the sun versus those in the shade. Sun leaves are smaller, thicker, and contain less of the green chlorophyll pigment, hence they are a lighter green in color. They may have a double layer of palisade cells. Cell walls are thicker. Since shade leaves develop during the acclimatization period, the sun leaves tend to fall first when such plants are moved inside. These carry on photosynthesis less efficiently and have a higher respiration rate than do shade leaves. The shade leaves on a plant may be twice as large in area as sun leaves.

Physical changes may take place within a leaf to make it better adapted to low light, even if it is a sun leaf. Chloroplasts are found just inside the cell walls in the cytoplasm. Under high light intensity, these are found primarily arranged along the vertical cell walls. Here they tend to shade each other, which protects them from excessive light. In addition to chloroplasts, flattened discs in shape, are exposing their narrower diameter to the strongest light.

Under low light conditions, the chloroplasts are found arranged more horizontally along the top and bottom walls of the cells. Their broadest diameter is facing the light source, also. The internal structure of the chloroplasts also differs. Small 'packages' of chlorophyll are stacked one on top of another making what is called grana in sun leaves. The bottom ones obviously receive less light than do the top ones. In shade leaves, these grana disperse so that the chlorophyll intercepts more of the light entering the cell. More of the chlorophyll can operate efficiently with this arrangement.

The total chlorophyll content increases greatly in leaves when they are shaded. This has cosmetic as well as physiological value. We like to see plants which are dark green in color, a result of the increased quantity of chlorophyll.

Physiologically, two vital changes occur which enable a plant to live and even thrive with less light. The light compensation point (LCP) is reached at lower light intensity, and the respiration rate of the plant drops drastically.

The LCP is that intensity of light at which a plant is manufacturing carbohydrates at the same rate as they are being used in the respiration of the living cells at the existing temperature. A plant consumes carbohydrates during the night without manufacturing any then, so it must have light about its LCP during the day just to break even in a 24 hour period. The length of the light period is also important of course.

Surprisingly, a plant's LCP is achieved under lower and lower light intensities as acclimatization continues. Pass and Hartley in Colorado found a reduction from about 132 foot-candles (ft-c) to 33 ft-c for Schefflera in only 7 weeks. The LCP of Boston Fern decreased 28% and that of Pothos 33% during the same time period. As these plants had been growing in greenhouses, they were undoubtedly partially acclimatized at the time the experiment started.

Fonterno and McWilliams in Texas used the procedures for acclimatization suggested by Conover and Poole and determined the LCP of 4 foliage plants. Heartleaf philodendron dropped from a LCP of 182 ft-c to 83 in 4 weeks and to only 39 after a total of 15 weeks, a reduction of 79% in required light. Schefflera dropped 71% in its requirement, to only 22 ft-c. Pothos dropped 84% to 33 ft-c. Sander's dracaena, a medium light plant, was much higher to begin with. It dropped 87% in its requirement to 83 ft-c.

These plants were being acclimatized by a light treatment of only 150 ft-c intensity each day for 12 hours. This was considerably less than they had been receiving in a greenhouse previously.

Vlahos and Boodley had Florida plants trucked to Ithaca, New York, for experimentation. After acclimatizing them in a greenhouse, they place them in the Cornell library where they received varying intensities of light. They concluded that the LCP of Weeping figs was 35 to 45 ft-c when the plants received 18 hours of light daily, some natural and some artificial. Scheffleras endured with as low as 20 ft-c of light, but did not grow unless they received as much as 200 ft-c.

The Florida research grew Weeping figs under varying intensities of light for 9 months. They found that the LCP varied with the intensity of the light. Plants receiving only one-fifth the light that unshaded plants received needed only one-third as much light for their LCP. That is, plants grown in full light and moved inside needed three times as much light to maintain themselves as did those grown in the reduced light.

Leaves in high light often have a reserve of carbohydrates stored in them, while those grown in shade don't. It might seem desirable to build up such a reserve with high light before putting plants inside under low light. Such plants simply use up this reserve and then suffer because of their inefficient photosynthetic mechanism and high respiration rate. The acclimatized leaves are able to manufacture enough food for the plant from the beginning.

Even delicate indoor plants may be acclimatized. In Florida, blooming African violet plants were put under light levels much lower than those recommended for flower production. Flowering promptly ceased. Those receiving about 186 ft-c for 12 hours a day, approximately one-third the recommended intensity, began to bloom within 3 months. Plants under 93 ft-c flowered after 6 months. At only 47 ft-c, no appreciable flowering occurred.

Flowering was correlated with the growth of new leaves on the plants. These new leaves were probably more efficient in photosynthesis with lower respiration rates. They could accumulate carbohydrates and so induce flowering, while the original leaves couldn't.

Indoor gardeners can utilize this increased knowledge of their plants' responses in several ways. First, they can inquire into the past history of large, expensive plants such as a large Weeping fig. That is, has it been acclimatized? If not, don't buy it. A reputable nurseryman or florist will know, so deal with people you can trust.

Since even an acclimatized plant continued to change internally to even lower light requirements, give it this opportunity. For the first month or two, give it high light intensity. That is, if a plant is listed as being adapted to from 75 to 150 ft-c, give it nearer the 150. This will insure its receiving adequate light while its LCP drops lower so that later the plant will endure with less light.

Giving a plant light for a longer period of time helps make up for the lower intensities found indoors. Sixteen hours of low light is better than 12. If an interior office is lighted only from 8 a.m. to 5 p.m., 9 hours, intensity must be greater than in an office or store where business hours are much longer.

One other factor should be considered when a plant is brought inside, fertilizer. Growers use enough fertilizer to encourage rapid growth. When the plant is brought inside under low light, its needs are reduced to only a fraction of what they were. When receiving only minimum maintenance lighting, the plant doesn't need more than a tenth of the fertilizer it needed when growing actively. When light is intense enough for fair growth, still only about a fifth the previous requirement is needed. The excess fertilizer should be leached out by flooding the container 2 or 3 times, allowing the excess to drain in between.

Outdoors, a plant goes through 4 seasons: winter, spring, summer and 'fall of the leaf', as our autumn season was originally called. Acclimatize your plants so they remain eternally in spring and summer. Don't let them ever reach 'fall of the leaf'!