CONDITIONING PLANTS FOR INTERIOR USE

D. F. Wetherell, Prof. of Plant Physiology
Botany Section, B.S.G., University of Connecticut

What is conditioning? How do plants respond to abrupt changes in their surroundings? What internal physiological processes must be taken into consideration to reduce stresses during the transition period as a plant adjusts to new conditions.

There is one important characteristic of most plants which we should recognize and keep in mind throughout this entire discussion. Plants lack the ability to move from one place to another. Consequently, under natural conditions, they are at the mercy of the environment in the location where they become rooted. The great variety of evasive strategies so widely used by mobile creatures, such as burrowing under a cool moist rock during the heat of the day, are not available to plants. They must "grin and bear" whatever stresses the weather and climate create.

An important means of adaptation is the ability of many plants to "custom make" some of their body parts and internal machinery to best suit the average conditions at the time of their development. For example, plants which develop in full sunlight can be structurally and metabolically quite different from those which develop in partially shaded conditions.

This adaptive mechanism seems to work well in nature where changes in average environmental conditions tend to be relatively slow and linked to the passing seasons. However, for the grower who finds it necessary to grow plants and then rapidly transfer them to an entirely different set of conditions, this characteristic can create serious problems. Plants which have developed much of their mature vegetative body in an irrigated field under high light, with ample amounts of fertilizer, have custom tailored their physiological equipment accordingly. This equipment may be seriously inadequate to meet the warmer, drier, low light conditions of a home or office "climate."

Some immediate emergency measures can take place to counter the new stresses--rate of water loss can be altered, reserve food supplies can be mobilized--but in the long run successful adaptation will require some reconstruction of the plant's machinery to match the new conditions. Often some of the old parts will be sacrificed to reduce the overall stress on the system and to allow reutilization of the materials. Nutrients and metabolites may be withdrawn from older plant parts and translocated to regions of new growth. Senescing older structures, especially leaves, may yellow, wither or be shed. Unfortunately, plants aren't very pleasing to the eye while such major renovations are taking place.

All environmental factors contribute information to which growing plants respond by adjusting their physiological processes. However, light intensity and water stress have the most conspicuous effects. Although these factors are clearly interrelated, we will treat them separately to simplify matters.

Adaptation to Changes in Light Intensity

Midday summer, or southern U.S. winter, light intensities may exceed 10,000 footcandles. The light intensity in a living room or an office lobby will be on the order of 50-250 footcandles. The photosynthetic machinery constructed to cope with the problems of the high light intensity found under field conditions is, in many cases, inadequate at lower intensities. Unshaded leaves can only use a portion of the light they receive under open field conditions--often less than 50% of full sunlight. To avoid injury from excess light absorption they utilize many mechanisms: reduced leaf size, more reflective surfaces, more efficient control of water loss, and less efficient light processing machinery. When such a plant is transferred to much lower light conditions, this machinery may prove to be quite inefficient.

Figure 1 gives such data for Solidago plants from the same clone but grown under two different light levels. When subjected to lower light intensities, the leaves grown at the higher light intensities have

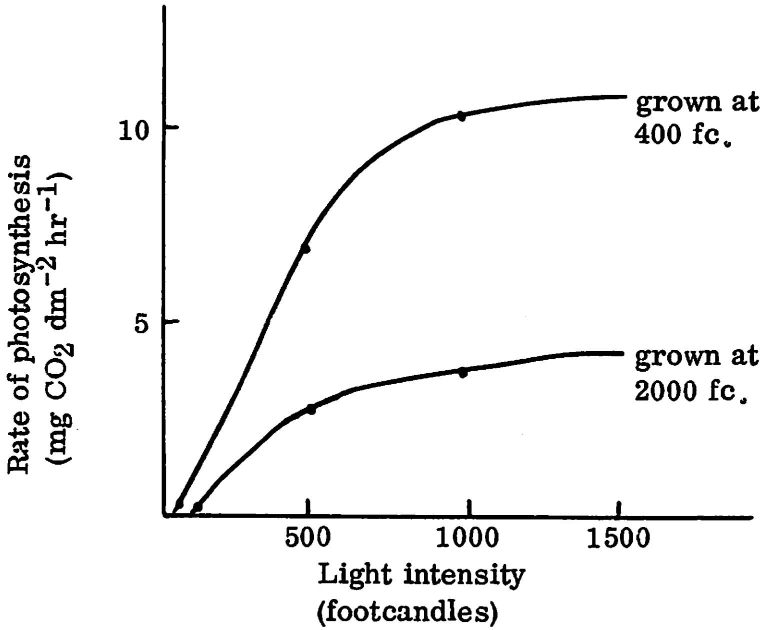

Figure 1. Photosynthetic capacity of leaves of Solidago virgaurea grown at different light intensities and then placed under low light intensity conditions. Modified from Bjorkmann and Holmgren, 1963. Physiologia Plantarum 16: 889-914.

less than half the photosynthetic capacity of those grown at the lower intensity. If air temperatures are high and there is some water stress, this difference could be enough to cause the depletion of reserve food supplies before adaptation to the new conditions could occur.

The seriousness of the loss of photosynthetic efficiency upon transfer from high light to low light conditions depends partly on the species involved and partly on the general health of the plant. With the Solidago used in Figure 1, Bjorkmann found that under ideal conditions a full transition from the low efficiency of the high-light-intensity grown leaf to the high efficiency of the "shade-grown" leaf required only a week. This is probably an exceptional case as other species have been shown to require much longer or even to be unable to successfully make such an adjustment. In the latter case, the leaves drop off and are replaced by a new growth of "shade tolerant" leaves.

Photosynthetic efficiency under low light conditions is only one measure of the differences between sun- and shade-grown leaves. Various workers have reported for a variety of plants that shade leaves are thinner and broader, have higher chloroplasts, higher nitrogen content, thinner cell walls and less vascular tissue, and are more conservative in their utilization of food materials in the leaf, especially at higher temperatures.

Adaptation to Changes in Water Stress

An abrupt imbalancing of the rate of water loss and the rate of resupply by the root system creates problems at least as complex and even more urgent than those created by light intensity changes. In order for photosynthesis to proceed at maximum rates, it is necessary that leaf pores (stomates) remain fully open. Any reduction in the size of the opening causes a corresponding reduction in the rate of photosynthesis. Even under favorable conditions, this creates a serious dilemma for the plant because open stomates allow the loss of precious water from the moist inner tissues by evaporation (transpiration).

A workable compromise between these conflicting needs is possible only as long as soil water is freely available and the size and health of the root system is adequate to absorb and transport sufficient quantities to the shoot system to prevent water dificits from developing. Ultimately, however, automatic water stress controls in the leaf have the upper hand and a plant experiencing severe water stress will shut its stomates and bring net photosynthesis to a stop with subsequent depletion of food reserves.

Changes in the relative humidity of the air surrounding the plant create large changes in the demand for water. For example, the water potential of air (the evaporative power of the air) changes with relative humidity as follows (temperature=80°F):

Relative Humidity (%)	Water Potential (bars)
100	0
90	142
70	488
50	947
30	1642
10	3142

Only the waxy, waterproof cuticle coating and the regulation of the stomate opening protect the wet living cells from rapid death by dehydration. Temperatures of $70^{o}F$ and relative humidities below 25% are common indoors during our winter.

Damage to the root system during transplanting or physiological damage caused by over or under-watering or by overfertilization results in unfavorable root/shoot ratios. Most of the absorption of water occurs through the extensive network of tender rootlets and delicate root hairs. Reducing the area or efficiency of this water absorbing region will almost immediately create water deficit conditions in the shoot system. Not only is the rate of photosynthesis impaired by such water stress, but powerful growth inhibitors are produced throughout the plant. In addition, replacement of the damaged or insufficient root system places heavy demands on the energy reserves at a time when they are most needed for the reconstruction of shade tolerant foliage.

One way which many plants respond to such emergency conditions is to initiate senescence in its older leaves. Nutrients and metabolites are withdrawn into the main plant body and these leaves are sealed off and dropped. Such measures quickly reduce water losses and provide a fresh new supply of raw materials and energy for rebuilding a better balanced, better adapted, root and shoot system.

With these physiological fundamentals in mind, plant "conditioning" becomes a matter of anticipating the kinds of problems that the proposed change in conditions will create for the plant and then applying your best horticultural skills to minimize the buildup of stresses during the essential transition period. A large and abrupt transition in light intensity and/or water relations, to name only two of the possibilities, is going to necessitate equally large changes in the plant as it struggles to acclimate. You cannot fool the plant. It will accurately reflect exactly what you have done to it.

All of these things, then, contribute to the importance of conditioning foliage plants before you sell them. Simply holding them in a shaded greenhouse for two to four weeks before selling will help. Then condition the customer by explaining the effects of a change in environment on the plant. Your sales should be more successful.

Suggested additional reading: (1) Acclimatization of Foliage Plants. C.A. Conover. So. Florist and Nurs., Vol. 88, #6, 9/19/75. (2) Light Requirements for Foliage Plants. R.T. Poole and C.A. Conover. Fl. Rev., Vol. 155, #4024, 1/16/75.