LIGHT IN PROPAGATION

ROSS JAMES

89 Gladstone Street,
Kew, Victoria

Lighting for specific results in plant propagation is an infant science awaiting our attention. The aim of this paper is to present a summary of available data together with my own thoughts. It is by no means exhaustive, serving only as an introduction to a fascinating aspect of plant propagation.

Consider these thoughts and their impact: Light — the most powerful environmental force; the omnipotent plant growth regulator; light is energy; light is essential for photosynthesis.

Light effectively regulates the rate and type of plant growth by determining the speed of energy assimilation through photosynthesis. Simply — NO light = NO photosynthesis = NO growth.

Visible light consists of a mixture of red, yellow, green and blue lights covering the range of wavelengths from 350 to 780 nanometers (nm). The two zones of most significance to plants are the blue zone (350-550 nm) and the red zone (550-780 nm). Photosynthesis is influenced by both zones but, in addition, the blue zone influences phototropic reactions; e.g. the growth of plants towards light, and the red and far red zones control flower initiation, seed germination and vegetative growth.

As propagators, we find ourselves faced with a dilemma - striking cuttings in as much light as is possible without incurring damage through excessive exposure. We require maximum levels to reach leaf surfaces for maximum photosynthesis and the production of "energized" cuttings.

Misting systems now permit us to propagate in brighter conditions than was formerly possible by obviating high leaf temperatures. Because of the climatic variations, reliance upon the sun to provide light of constant quality and quantity is uncertain. It seems logical then, to turn to artificial sources during the low light periods.

It is important to grasp the essential distinction between "light quality" and "light quantity." Quality refers to the spectral range emitted, or more specifically, the percentage of light that is absorbable (useable) by plant material. The quantity or brightness describes the concentration per unit area in lumens/square metre.

Both factors demand separate consideration for they are not the same, and are not necessarily related. As noted earlier, the spectral range to which plants respond falls between ca. 400-780 nm. In order to coincide with the peaks of photosynthesis, sources should have highest output in the 600-700 nm band (orange/red), with lesser percentages in the 700-800 nm (far red) and 400-500 nm (blue) ranges. The type of illumination used should give plants with the same characteristics as those grown under natural daylight.

LIGHT SOURCES

(a) *Solar energy*, as we know it, has inherent limitations, not the least of which is the variable daylength. Nonetheless it is free and the wise propagator strives to capture and utilise all that is available.

(b) *Artificial lighting* enables production of better quality material at times of low light, by increasing growth during the brighter period.

Essentially lighting regulates two aspects of plant growth:

(i) photoperiodism
(ii) photosynthesis

In propagation, photoperiodic manipulation is not usually a consideration, except, perhaps, for out-of-season crops, including poinsettia and chrysanthemum.

The main interest lies in the field of photosynthesis. Here we have three choices:

(i) daylight extension - requiring 5-50 watts/sq metre.
(ii) supplementary (dark day) requiring 50-100 watts/sq metre.
(iii) total source - requiring ca. 500 watts/sq metre.

The advantages of each are obvious. However, the criterion must surely be the cost/benefit to the nursery. The levels required for photosynthesis are some 10 to 100 times greater than those for photoperiodic regulation. It follows that lighting must be done efficiently. Plants have saturation levels above which a protective mechanism prevents further assimilation — thus illumination above these levels is wasted.

The aim is to keep saturation levels for as long as possible. Unfortunately little information exists prescribing optimum levels for different crops. Hopefully a handbook will soon emerge for each commercial crop, listing correct level and spectral content required.

HORTICULTURAL LAMPS

Despite extensive experimentation, the ideal horticultural lamp has not yet emerged. No doubt this reflects the sometimes contradictory responses of plants and the limited demand for such a lamp.

However most literature lists the following factors as important in evaluating the suitability of available types:

(i) efficiency between 400 and 700 nm (i.e. percent input converted to visible radiation).

(ii) qualtity of emission.

(iii) economics (capital outlay, cost benefits, power consumption)

(iv) suitability to existing setup.

Inevitably selection is a compromise between desirable and practicable factors. You must choose.

Currently incandescent (tungsten), fluorescent, and gas discharge (sodium and mercury vapour) lamps are used in nurseries. Of these the fluorescent tube finds greatest favour in propagation. It is readily adapted by coating with various fluorescers to emit specific spectral ranges. It has an acceptable form, and because of low heat output, can be placed close to the cuttings for better illumination. Despite high installation costs, power consumption is low and efficiency is good.

The "Grolux" lamp is a response to the needs of the horticultural industry. Interestingly, the "white" fluorescent group, especially the "warm white" tube, produces light with a high percentage of absorbable light and has a cost advantage over more specialised types. The colour coded types viz. C 29, 32, 33 and 34 are good, C 33 being the best (3).

Incandescent globes have a high far-red content and cause excessive stem elongation and high leaf temperatures. Their main application is in night-break lighting of chrysanthemums, particularly where winter stem growth is inadequate. They are occasionally used to supplement fluorescent lamps.

Both mercury and sodium vapour lamps are used for daylight extension. The high energy levels are suitable for the broad lighting of young plants (and cuttings).

To the propagator light is a tool whose manipulation may well revolutionise our thinking. Already we have learnt flowering control of out-of-season crops. Researchers and plant breeders shorten the time to see the results of their work by up to 50%. Growers light their trees and shrubs to extend the growing season and to keep plants vegetative for extra cutting material. Seedlings are produced to predictable schedules. "Energized" cuttings perform better.

In conclusion a quote adapted from A. E. Canham (2) is appropriate. "The most successful grower is the one who learns to use not only his experience, but also that of others, to persuade plants to grow when climatic conditions are least favourable."

LITERATURE CITED

1. Bickford, E. & S. Dunn, 1972. Lighting for Plant Growth. Kent State Univ. Press.

2. Canham, A. E., 1966, Artificial Light in Horticulture. Eindhoven, Centrex.
3. Templing, B. C. & M. A. Verbruggen, 1975. Lighting Technology in Horticulture. Phillips Industries, Eindhoven. The Netherlands.

QUESTIONS

In reply to questions Ross explained that as far as light is concerned, glass as a covering for greenhouses permits maximum passage of light, but it filters out the ultra violet rays. Plants taken from here into direct sunlight can be burnt by the UV. Fibreglass gives better growth because it diffuses the light, but its disadvantage is the deterioration of the surface over the years. Polythene is rather similar but it does collect dust.