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## Appendix

# Crop Growth Requirements

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The following table of growth requirements is for plant species commonly grown in enclosed environments and provides suggested conditions to simulate average growth in field environments and commercial facilities. These are general suggestions that will provide good growth; it should be recognized, however, that conditions may differ for specific cultivars and may differ in particular commercial production facilities to fulfill specific quality or other requirements. Detailed information on nutrient solutions, lighting system lamp types, growing media, etc., is contained in the previous chapters of this handbook.

## ENVIRONMENTAL CONDITIONS

### *MEDIA AND NUTRITION*

Plants usually will be grown in a soilless potting medium or liquid culture. Several commercially available mixtures provide suitable media for plant growth, as discussed in the previous chapters. When plants are grown in a soilless media or liquid culture, use of a complete nutrient solution (approximating half strength Hoagland) is recommended, with the nitrogen concentrations modified as indicated in the table. Nitrogen is emphasized because this is the principal nutrient that is altered for a particular species or at particular stages of growth. If a soil-containing medium is used, it is recommended that the plants be fertilized with a commercial water-soluble fertilizer such as 20-10-20. When nitrogen concentrations are modified with a commercial fertilizer, P and K concentrations will also be modified. Recommendations for pH

assume that a range of 5.5 to 6.5 is acceptable for most plants, and a pH of 4.5 to 5.5 is acceptable for crops requiring low pH.

### *LIGHT*

The recommended photosynthetic photon flux (PPF) is for the top of the canopy. When light is indicated to be 12-20 hours, there is no specific daylength requirement for this species. The use of the longer period will provide a greater amount of total lighting, and thus an intensity toward the lower end of the recommended PPF range can be utilized to achieve good growth. If a short photoperiod is recommended, it is necessary to provide an intensity toward the high side of the recommended PPF range. No recommendations are provided on light source because chamber configuration, plant species, and desired response can all affect lamp selection. Users are referred to specific chapters in the text for detailed lighting design considerations in controlled environments. Special light requirements for specific species are noted in the comments column of the table.

### *TEMPERATURE*

Recommendations are for air temperature at canopy height. The temperature for most plants can be set 2 °C above or below the indicated temperatures and still produce normal plants, although growth rates will be altered. A light/dark fluctuation is recommended, and is required when shown in bold letters; most plants, however, will develop normally with a constant temperature that is an average of the indicated light and dark temperatures. The temperature period required to break bud dormancy of woody spe-

cies is cultivar dependent; thus, a range of time is indicated.

#### **RELATIVE HUMIDITY**

Control between 60 and 70% relative humidity is recommended for most crops and can be achieved readily in most controlled environment chambers. Exceptions are noted in the comments column.

### **STAGES OF CROP DEVELOPMENT**

The environmental conditions required for successful plant growth in controlled environments are often not the same throughout all stages of plant growth. For that reason, the table has been divided into four, somewhat arbitrary, stages of development: Propagation, Vegetative, Flower Initiation/Development, and Fruit/Seed Development. These categories may not be technically correct for all the plants described, but they should provide functional guidelines for maintaining a desired growth rate for the listed species.

*Propagation* is considered the period from planting to emergence of the first true leaf. En-

vironmental conditions for acclimation of tissue-culture transplants, seedlings, and rooting of cuttings are also included in this section when they are considered to be routine propagation methods.

*Vegetative* is the period when reproductive structures are not actively developing on the plant. This typically includes the period of rapid stem elongation and leaf expansion that precedes flower formation. For woody species, this period may include the period of stem and leaf growth that occurs when flower buds are present but dormant.

*Flower initiation/development* is the period from the initiation of flowers through shedding of pollen (anthesis), flower formation, pollination, and fertilization. However, for many perennial woody plants, initiation of flower buds occurs at a time separate from flower development. The recommended environment for breaking dormancy of the initiated flower buds of these woody species is indicated in the comments column at the right margin.

*Fruit/seed development* is the period following fertilization to maturity of the seed.