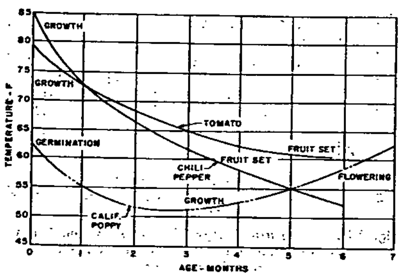

Fig. 16 .... Optimum Night Temperatures for Growth and Reproduction of Several Plants[48]

optimum conditions during all stages of development. However, the optimum temperature is related to other environmental factors[48,49] and may be altered by changes in water relations, light intensity, etc. Controlled environment facilities to study specific problems such as lethal temperatures or transpiration and evaporation of water may require temperatures as high as 110 F. Studies of dormancy, vernalization, and winter hardiness require temperatures of − 60 to + 50 F, and termination studies require temperatures from 35 to 95 F. However, most plants are grown in controlled environment chambers at temperatures between 50 and 80 F, frequently with the light and dark period temperatures differing by 10-15 F deg. Many investigators, after preliminary experimentation, settle upon one temperature regime and seldom change it.

Dry-bulb temperatures may be misleading: The leaf or soil temperature is significantly higher under sunlight or incandescent light than under fluorescent light with equal foot-candle readings.

The effect of temperature fluctuations on plants is a function of the magnitude and the frequency of the variations. Little detailed information is available on the effect of the size of the temperature differential from the control point when the cycles are relatively rapid. However, each biological investigator should have some indication of the temperature variance allowable for his particular studies, and will specify his requirements.

Humidity

Very low or very high humidity has a marked effect on plant growth by influencing secondary factors, such as making the plant more susceptible to diseases by providing a better environment for pathogenic organisms. Many existing controlled-environment rooms maintain 55 to 65 percent relative humidity at 70 to 75 F, without any attempt to control humidity. Since plants must be watered one or more times daily, the relative humidity in some rooms will rise to 90 or 95 percent for a brief period following the application of water to the plants.

Wind

Wind velocity influences many factors that affect plant growth, such as transpiration, evaporation of water from the soil, and availability of CO_2. As a result, leaf size, internode length, and other aspects of plant growth may be altered. However, wind direction itself does not seem to be important (Fig. 17).

The biologist usually prefers a minimum amount of leaf movement, but he will usually have to compromise and permit some leaf movement, to obtain the air velocity necessary to maintain the desired temperature. Air speeds of 50 to 150 fpm in an empty chamber are usually considered reasonable. When pots containing plants occupy half the bench area, air directed upward through the bench and between the pots will have about double the velocity of air passing through an empty bench.

Plant variance at various positions in the chamber may be the result of differences in wind velocity. Soil evaporation

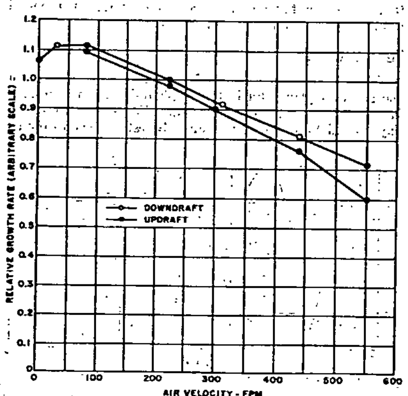

Fig. 17 .... Effect of Air Velocity on Growth Rate of Leaves[50]

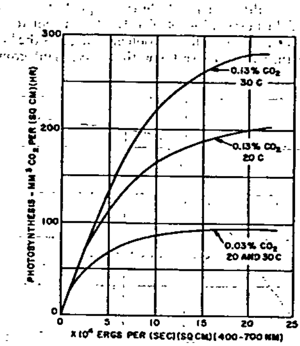

Fig. 18 .... Photosynthesis of a Cucumber Leaf at a Limiting and Saturating CO_2 Concentration Under Incandescent Light[53]

and temperature, leaf transpiration and temperature, ambient air temperature, and relative humidity are all affected by air velocity. Since one of the reasons advanced for the use of controlled environment facilities is to reduce such position variance, uniform air flow over the growing area is a major design factor.

Air Composition

Efforts are currently being made to control the composition of the air in plant growth chambers. Smog, industrial fumes, and radioactive materials are being studied, and the effects of increasing the CO_2 content of the controlled environment room atmosphere are receiving special attention.[52]

In the photosynthetic process, plants absorb CO_2, which makes up about 0.03 to 0.04 percent of the normal air, through small openings in the leaves called stomata. The amount of CO_2 required for maximum plant growth depends upon the stage of growth, leaf area, light intensity, temperature, wind velocity past the stomatal opening, and a number of other factors. The rate of photosynthesis is usually limited by the low concentrations of CO_2. It has been shown experimentally that an increase of normal atmospheric CO_2 from 0.03 to 0.13 percent causes a corresponding increase in the photosynthetic rate, and that the increase obtained depends on the temperature (Fig. 18).

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