JOINT COLLOQUIUM

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Two overseas scientists, Professor F. L. Milthorpe of the Department of Botany, University of Nottingham, and Mr. L. G. Morris of the National Institute of Agricultural Engineering, Silsoe, Bedfordshire, England, who were attending a conference on microclimatology organised by the C. S. I. R. O., addressed the colloquium. Summaries of their talks are below.

WEATHER AND PLANT GROWTH

by F. L. Milthorpe

Adequate understanding of the relationships between plant growth and the weather depend on a detailed understanding of two general facets - (i) the nature of plant growth and the components of yield and (ii) detailed analyses of the environments of individual plants in the different agricultural and natural communities.

The season of the year when a species grows is determined either by temperature or by water and is usually of limited duration. The final yield is a resultant of "growing conditions" during this period and depends largely on the rate of growth during the three main autogenetic stages of germination, vegetative growth and reproductive growth. Germination is a function almost entirely of temperature and water supply, there being as yet no adequate description of the latter in relation to germinating seeds.

The rate of vegetative growth is determined mainly by initial seed weight, by species and by weather, of which temperature, water and light are the chief components. Species differ little in their temperature optima or growth rates at supra-optimal temperatures but vary widely in response to sub-optimal temperatures. The conversion of radiant energy into new plant tissue is usually limited more by supply of mineral nutrients than by supply of light or carbon dioxide, although the former may be short in dense communities. Recent analyses of the light, carbon dioxide and temperature profiles in crops have led to a much clearer appreciation of the significance of these components, but knowledge on nutrient supply is still meagre.

Plants must be grown in dense stands to obtain maximum utilization of light and carbon dioxide supplies; this leads to a smaller root system and less utilization of nutrients and a greater danger from water shortage. We have a much clearer appreciation of water as an ecological factor than of all other weather components. Evaporation can now be estimated with reasonable accuracy and water absorption with less precision. If evaporation demand exceeds absorption - this being related to soil water content and potential evaporation - then transpiration and growth rates are reduced.

Flowering is influenced mainly by length of day and by temperature. Fruit yield is a resultant of the initial size and number of flowers, which is determined by vegetative growth, and by light, temperature and water supplies during the period of fruit growth.

GLASSHOUSE CLIMATES

by L. G. Morris

This talk is confined mainly to the engineering problems concerning the glasshouse industry in the United Kingdom where it covers an area of about 5, 000 acres and is worth about £stg 30 million annually. The glasshouses are used the year round and the crops are mainly tomatoes, but also cucumbers, lettuce and flowers.

It is necessary to have glass houses heated in winter and ventilated in summer since specific temperatures are required to maintain optimum growth, flowering and fruit-bearing.

These temperatures, however, are not yet known with sufficient precision.

The plants in these glasshouses require watering. For this purpose automatic irrigation has been designed but the cost has to be considered. Experiments on the effect of environment on water loss have been carried out for some years by growing plants in lysimeters as has been done at Aspendale, Victoria, by the C. S. I. R. O. For a horizontal green surface, the monthly mean daily water loss, y, in millimetres, has been found to be

$$y = 0.384X_1 + 0.172X_2 - 0.172$$

where X_1 is the monthly mean daily net Solar Radiation inside the glasshouse (cal/cm^2) and X_2 is the monthly mean vapour pressure deficit of the outside air (mm. Hg).

The vapour pressure deficit is, however, sufficiently related to solar radiation for estimates of water loss to be based on solar radiation measurements alone in planning the watering programme for tomatoes.

In the detection of air temperature inside glasshouses, either for measurement or for control, shielding from radiation exchange and aspiration are both important. Exposed, unaspirated thermographs have recorded errors of +28°F due to sunshine and -3°F at night due to radiation to cold glass. Aspiration also increases the response of the detector to fluctuation of temperature, so improving control and measurement; a thermograph (in a glasshouse heated under on-off control) recorded $6\frac{1}{2}$°F fluctuation when aspirated and only 2°F when not. N. I. A. E. have designed an aspirated screen which is used by many research workers and growers for housing thermostats and thermographs.

To compare the average night-time air temperature at many points in a glasshouse the fluctuations due to on-off control were eliminated by immersing each thermometer bulb in a 2 lb. jar of water. Readings taken just before dawn revealed longitudinal temperature variations in the glasshouse due to the presence of four convection cells. These can be dispersed by applying all the heat at the side walls instead of uniformly over the soil area, so that the air circulates within the cross-section.

In considering the use of polyethylene film as a substitute for glass, an important property is its transparency to almost all wavelengths of radiation, while glass is only transparent to solar radiation. Consequently, the grass minimum temperature in frosty conditions can be lower in an unheated polyethylene enclosure than in the open, while under glass it is always higher. In heated greenhouses with equal air temperatures, heat losses through glass and polyethylene were similar, but plant temperatures were lower under polyethylene, so that for equal plant temperatures, about 20 per cent more heat was required. The presence of water on the polyethylene reduces but does not eliminate these effects of transparency to long-wave radiation.

Plant temperatures on propagating benches were next discussed. Pots can lose heat by the evaporation of water and by radiation to the cooler glass. If the bench is solid, cooling can be intensified by the accumulation of a stable layer of cooled air round the pots. Thus non-porous pots are warmer than porous ones and an open bench of wire mesh or of slats is preferred to a solid one. Plant and soil temperatures were shown for various combinations of pot and bench and the corresponding plant weights varied in the range 1 : 2.

Methods of automatically watering pots by capillary action were shown for both solid and slatted benches.