New phytotron widens scope for research

Department of Agriculture, Western Australia

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New phytotron widens scope for research

A WIDE range of new experiments and greater speed and efficiency in many existing projects has been made possible by the recent completion of the Department of Agriculture phytotron at South Perth.

The phytotron, officially called a "controlled environment facility" is in fact a rather unobtrusive building housing compartments in which agricultural scientists can regulate the climate to suit plant experiments. Selected conditions for plant growth can be maintained indefinitely, giving ideal conditions for plant research.

The building contains four enclosed cabinets in which temperature, day length, light intensity and (in two) humidity can be fully controlled. Attached are two glasshouses in which temperature and day length are controlled but light intensity is determined by natural sunlight.

The ability to select growing conditions at will allows the scientist to create an artificial climate in which factors such as temperature and light intensity are varied independently rather than together, as usually happens in the field. It is also possible to imitate any natural climate if this is required.

Another great advantage of the phytotron is that it is possible to repeat experiments under identical conditions, so that results can be compared exactly.

Complete control of environment removes the limitation of being able to grow only one generation of a seasonal plant each year. For example, three successive "winters" may be created in one year so that three crops of a winter-growing species can be grown in the time that one generation is grown in the field or in a conventional glasshouse. The tremendous advantages of this for the plant breeder are obvious.

In an ordinary glasshouse, field hazards such as frost, floods or straying stock can be eliminated but climate cannot be controlled. Summer temperatures in a conventional glasshouse are too high for plant growth so that in practice it can only be used for about eight months of the year. The phytotron can be used continuously.

One of the first series of experiments in the phytotron is a basic study of the physiology of the wheat plant—testing how it reacts to changes in climatic factors such as temperature, light intensity and day length. The Plant Research Division is conducting these experiments to study the plant's responses to ranges and extremes of each factor individually and in combination with the others.

Information gained from these tests will be used in breeding programmes and for matching varieties to particular environments.

In the glasshouse section of the phytotron the plant breeding section of the Wheat and Sheep Division is testing new wheat varieties for rust resistance under conditions ideal for rust. Although rust resistance trials can be carried out in the
field or in a conventional glasshouse, the results are less reliable since the climate can not be adjusted and there is no certainty that weather conditions suitable for rust will occur in any one season.

The controlled environment growth cabinets are lit by fluorescent tubes and ordinary light globes which give light of a similar composition to sunlight, but less intense. The maximum brightness of this artificial lighting is 4,000 foot-candles, compared with the range of natural sunlight intensity from 1,000 foot-candles on an overcast winter day to 10,000 foot-candles on a very clear summer day.

Lights in the glasshouse section allow day length to be prolonged when required.

Temperatures are regulated by a refrigeration plant which transfers heat to or from water in a 7,500 gallon storage tank. During the day water is warmed by heat removed from glasshouses and cabinets; the warmed water is stored, then heated if necessary and re-circulated to provide heat for the phytotron at night. Temperatures in the phytotron can be controlled very accurately—within 0.2 deg. C. in the growth cabinets.

Lighting and temperature in all compartments of the phytotron can be regulated by time clock so that an experiment can be controlled automatically. This means that the dials on the master switchboard can be set to give a particular cabinet, for example, alternating periods of 12 hours full light intensity at 20 deg. C., then 12 hours darkness at 15 deg. C.; once the controls are set, the research worker can leave the experiment indefinitely without further adjustments.

A series of safety devices ensures that temperatures do not go beyond the set limits. There are individual controls on each compartment in the phytotron as well as on the master switchboard.

Disease and insect control is a big problem when plants are grown in closely-confined conditions. Larger insects can be screened out but there is always a risk of people or material coming into the phytotron carrying very small insects such as thrips. Diseases caused by bacteria, virus or fungi can not be completely prevented. In other parts of the world elaborate precautions have been taken to keep growth compartments sterile (for example, in the C.S.I.R.O. phytotron at Canberra, research workers must wash and change their clothes before entering the phytotron) but even so outbreaks of disease can occur. Insecticides and fungicides may upset delicate experiments, so are not generally used.

Because conditions in a phytotron are highly artificial, experiments must be planned so that results from this idealised environment will still hold under practical field conditions. One example of this is the present rust-resistance experiment where wheat proved resistant under ideal conditions for rust can be safely recommended to farmers.

The phytotron has so far cost about $70,000 to build and two more fully-controlled growth cabinets can be installed in the future. Running costs are also high—for example fluorescent lighting tubes alone will cost $1,000 a year. However, the advances in plant breeding and research made possible by the phytotron are expected to far outweigh the cost.

Major contributions to the cost of building the phytotron were made by the Trustees of the Grain Pool of Western Australia, the State Wheat Research Committee, the Wheat Research Council and the Wheat Industry Stabilisation (Disposal) Fund.

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