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PHYTOTRON IN THE BOTANICAL GARDENS OF THE ATTILA JÓZSEF UNIVERSITY, SZEGED

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A more and more indispensable condition of the plant ecological investigations is the phytotron. Plant breeding under precisely controlled conditions enables us namely to study the effects of environmental factors in an exact way and, in addition, it considerably accelerates also the realization of practical targets, e.g. in the field of plant improvement (BOUILLENNE—TOUILLENNE, WALRAND, 1950; BRAAK—SMEETS, 1956; FRENYÓ, 1963; TUMANOV, 1959; WENT, 1950, 1962).

After recognizing this, I tried about 15 years ago to construct a conditioning equipment suitable for plant breeding. First the so-called „light thermostat", known from the literature (ZAHN—FRIEDRICH, 1960), too, had been constructed (HORVÁTH—KOLTAY, 1963), in which, anyway, the daily rhythmic regulation of temperature and vapour content was but limited. The following step was to construct a „dwarf phytotron" in the Agrobotanical Gardens of the University of Agricultural Sciences, Gödöllő (HORVÁTH, 1964), regulating the intensity of illumination, the length of the time of illumination, the daily rhythmic change in the intensity of illumination and in the spectral composition of light, the temperature and vapour content, and providing for the constant, natural gas-composition of the air. In the course of operating the „dwarf phytotron" I came to know that a phytotron could be constructed more simply by making only the change of one of the environmental factors be of wide spectrum, regulating the other factors but in a more limited interval. The factor regulated in a wide spectrum is determined by the programme of investigations. In our case, this factor is the light. Starting from this principle, I drew up the plan of a so-called „block phytotron" (HORVÁTH, 1965) on the basis of which, in 1970, I succeeded in constructing our phytotron in the Botanical Gardens of the Attila József University, with the help of the University and the Ministry of Education. This enables us, with its size and capacity, to investigate multilaterally the effect of the light factor.

The phytotron is placed in the middle of a building built for that purpose, surrounded with laboratories. The central location is advantageous because then the temperature effect of the environment is but of low degree. (A location in the basement could have been solved only with difficulty because of the high watertable). The outlines of the phytotron building are illustrated in Fig. 2.

Fig. 1. Building of the phytotron. (Photograph: Dr. S. GULYÁS).

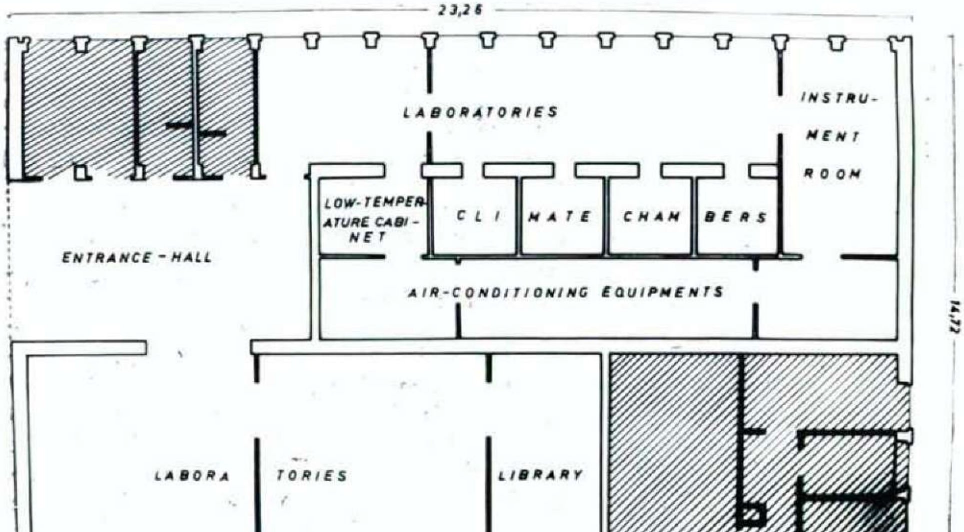

Fig. 2. Ground-plan of the building of the phytotron.

In the phytotron there are four climate chambers at disposal for growing plants, their cubical contents being eight sq.m each ($2 \times 2 \times 2$ m). The climate chambers are separated from the lamps by a plexi-glass top. The lamps exert, therefore, hardly any influence on the temperature. It is to be attributed to that that at a lighting with fluorescent tubes of perpendicular placing this influence is virtually nought. In the phytotron, light, temperature, vapour content, air motion can be regulated according to a programme, the gas-composition of the air is permanent, corresponding to the atmospherical gas-composition. The latter one is provided for by the ventilation assuring the air change at least twenty times an hour in the climate chambers and the air supply taking place through a ten metres high chimney-stack rising over the building.

Light conditions

The length of lighting time is regulated by electric switching clocks. For source of light we use 40 and 60 w fluorescent tubes and tungsten electric bulbs (during the development also luminous sources of other type — e.g., halogen lamps — will be used). With 80 w fluorescent tubes, in 25 cm distance from them, the illumination intensity is 15—18.000 Lux and after combining fluorescent tubes and tungsten bulbs 20.000 Lux. By applying fluorescent tubes of various types and tungsten bulbs, as well as filters, we can regulate the distribution of spectral energy, as well.

Temperature

The temperature can be programmed with the present cooling (15.000 cal) and heating (15 kw) capacity independently of the outdoor temperature, between 15—30 °C, changing in daily rhythm. The thermostatic control takes place by means of an ether-membrane thermoregulater designed by us, with ± 0.5 °C accuracy. With a programme-disc mounted on the 24 hrs switch clock — an which temperature is proportionate to the ray — any daily rhythm can be programmed in the temperature interval marked.

Vapour content

For regulating the vapour content, we exsiccate, with cooling, the inhausted air that is often of higher vapour content than necessary. This cooling is carried out, independently of the outdoor temperature, to + 5 °C. The air cooled to 5 °C and having 100 per cent relative vapour content is at its heating to 20 °C of about 40 per cent relative vapour content. That renders possible at 20 °C or at a higher daily temperature to programme the vapour content of the air withing a relative humidity of 40 to 95 per cent in daily rhythm. The humidity recorder is a hair hygrometer, transformed by us, in which — similarly to the termo-regulator — the vapour content desired is adjusted on the programme-disc. On this programme-disc, the ray is proportionate to the relative vapour content.

Vaporizing is performed with a so-called vaporizing mushroom of type VISZÉK L 5 (made in Hungary), vaporizing water-drops of about 20 μ. The tiny water-drops evaporate fast, there doesn't appear any liquid water-condensation.

The accuracy of the vapour content regulation is ± 2 per cent.

In addition to regulating the vapour content, a part of pre-cooling the air is, as well, to cool the luminous sources. The cooled air is namely led above the plexi-glass top, beneath the lighting system. As a result of the heat produced by the lighting system — as depending upon the luminous sources applied — the air warms up to 20 to 25 °C and gets into the chamber where — by cooling, resp. getting on with heating it — the desired temperature is brought about. From there the air of proper temperature gets into the so-called distributing room where the vaporization takes place according to the programme.

The importance of regulating the temperature and vapour content is illustrated with the thermohygrograph tape for one week, shown in Fig. 3.

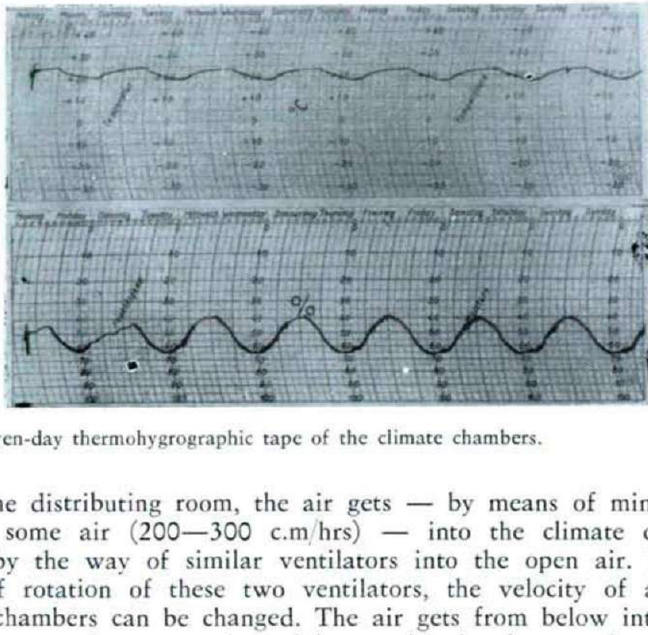

Fig. 3. The seven-day thermohygrographic tape of the climate chambers.

From the distributing room, the air gets — by means of minor ventilators transporting some air (200—300 c.m/hrs) — into the climate chambers and from there by the way of similar ventilators into the open air. By regulating the speed of rotation of these two ventilators, the velocity of air motion in the climate chambers can be changed. The air gets from below into the climate chamber, streams aslant upwards and leaves the chamber on the top. Any air-motion is promoted in every direction, apart from the ventilators, by a deflector, as well.

The ventilators are inducing in the phytotron some air-overpressure of lesser degree, decreasing the vitiation of air from the adjacent rooms.

The energy demand of the phytotron is, depending on the conditions realized, 10 to 30 Kw/hrs.

It is proved by our investigations — operated nearly continuously — that in the phytotron several cultivated and wild plants, and even some parts removed from the natural stands („sods of grass") are developing well and the plants can be grown until the ripening of fruit (Fig. 4).

The conditioning equipment has been constructed with the participation of technician GYÖRGY ZIMONYI. I wish to express my thanks to him in this way, too, for his work.

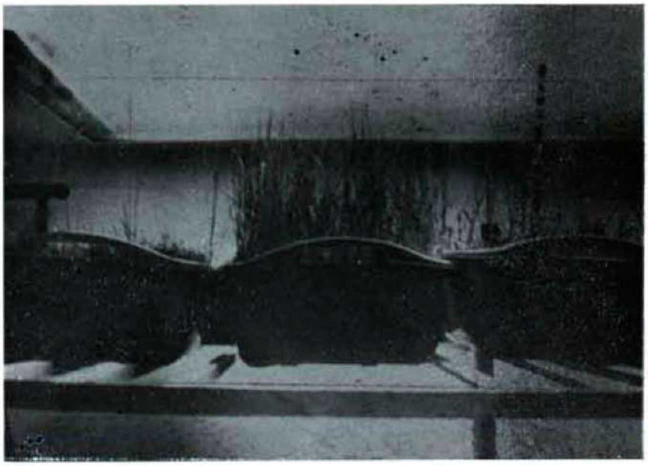

Fig. 4. Phytocoenosis investigations in the phytotron.

Summary

The phytotron constructed in the Botanical Gardens of the Attila József University is promoting, first of all, the comprehensive study of the effect of light factors. Temperature and vapour content can be programmed changing in daily rhythm. The illumination intensity can be increased with the luminous sources applied until 20.000 Lux. The gas-composition of air is constant and corresponds to the gas-composition of the atmosphere.

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