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PHYTOTRON –AN UMBRELLA FOR PLANT PHYSIOLOGICAL RESEARCH

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ABSTRACT

Plant research is based on climatic conditions as most crops are season bound. A researcher has to wait until the particular crop season arrives to do meaningful research. An accelerating approach to improving different food crops has led to controlling environmental research in the recent past where plants can be grown round the year irrespective of the season outside. Phytotron is one such facility that helps the researcher grow plants under artificial environmental conditions to see the plant performance under regulated environmental conditions as per the need of the experiment. In the phytotron, all the environmental conditions can be simulated artificially irrespective of the season outside, giving the necessary boost for accelerating the plant physiological research.

INTRODUCTION

Phytotron are the most complicated sort of controlled-environment facility. Artificially and naturally illuminated controlled-environment rooms and cabinets are utilized with incubators, seed germination chambers, roomettes, photoperiod rooms, and mechanically cooled greenhouses to offer different environmental conditions. Phytotron are differentiated from the installation with a few plant growth chambers by the fact that phytotron are managed in such a manner that an extensive range of many environmental parameters may be evaluated concurrently. Phytotron have an operational crew of professionals to maintain the equipment and the experimental material. Scientists, however, focus on research rather than the maintenance and operation of equipment. Phytotron also make optimal use of controlled environment space as they get frequent treatment without idleness and downtime due to failures that typically define plant growth chambers.

Phytotron are mainly employed to examine how the environment regulates and alters plant growth and development. Still, they are also utilized to complement and enhance field and greenhouse studies in areas like plant breeding and new plant species and types. Phytotron, however, also serve a crucial role in many areas of ecological study. Since plants may be grown and developed in phytotron at speeds and with chemical compositions that match definitions of "normal," they enable extensive investigation of the physiological and biochemical systems influenced by climatic stress.

PHYTOTRON AND PLANT PHYSIOLOGY

Environmental stressors, including drought, high temperature, and salt, continue to severely reduce agricultural output in India and numerous developing nations. The agricultural production is poor and inconsistent, owing to harsher surroundings. Due to high input technology, the recent crop production gains in vast swaths of irrigated land have not been observed in these stress-prone locations. Consequently, there is a great worry about the influence of abiotic pressures on agricultural systems now when we speak about food security and sustainable agriculture in the new century. Therefore, national and international research programs emphasize generating adaptive genotypes to varied conditions (Caldwell, 1994). The adaptations and reactions of plants to climate are numerous, nuanced, and not completely understood. Environmental elements having a substantial impact on yields such as water availability, temperature, radiation, and day length (Dohring,1996) sometimes are co-varying to such a degree that it is tough to untangle the climatic responses of plants in the field. Due to seasonal weather conditions, confirmation or comparisons of findings under comparable stress settings can require more prolonged durations. Therefore, it is necessary to complement the field studies with experiments conducted under precisely controlled environments, as elegantly highlighted by Caldwell et al. (1994b), to resolve which environmental factors and physiological processes limit plants' response to complex stress conditions. In terms of both area and diversity of circumstances, a facility of significant size is a tremendous asset since many plants and numerous combinations of climatic components may be treated concurrently, and this is precisely the notion of a phytotron.

Phytotron primarily consists of two sections

1. Complete artificial growth chambers
2. Partial control greenhouse

Growth chambers are completely controlled rooms where light, humidity, temperature, and CO_2 may be adjusted precisely. The temperature in these compartments is regulated by specific solenoid valves, which enable the plant to develop normally. They feature a particular RAMP mode through which the temperature shift is extremely gradual, and the plant never suffers a rapid spike or decrease in temperature. The temperature of plants influences several physiological processes. The researcher also manages plant development to match his demand and the light and humidity controls. The monitoring and management of temperature are crucial in all biological investigations. Adequate air circulation is crucial in conditioning temperature and wind velocities of roughly 0.5 to 1.0 m s^{-1} at the leaf canopy level are necessary to achieve optimal convection heat transfer in growth chambers. The significant energy loss via evaporation primarily accounts for a plant’s capacity to adjust its temperature within medically tolerable ranges. Aspirated boxes are generally utilized with an airflow no less than 3 m s^{-1}. The impact of humidity on plant development involves monitoring and control in growth chambers to guarantee uniform plant response and subsequent interpretation of experimental data. The most significant and direct impact of humidity on plants is transpiration, water from plant surfaces into the atmosphere.

The movement of water and growth ingredients from roots to shoots is triggered by transpiration. Humidity also impacts gas exchange via direct regulation of stomatal opening. The force driving transpiration is the water vapour pressure differential between the evaporating surface and the surrounding atmosphere. It is commonly stated as Vapour Saturation Difference (VSD) or Vapour Pressure Deficit (VPD) (VPD). Humidity regulation is also vital to developing plants. In phytotron growing chambers, the humidity rise and reduction are considerably more exact. Special nozzles are being utilized outside the rooms, and these nozzles generate a mist mixed with air, and this air is cycled to maintain the proper humidity level.

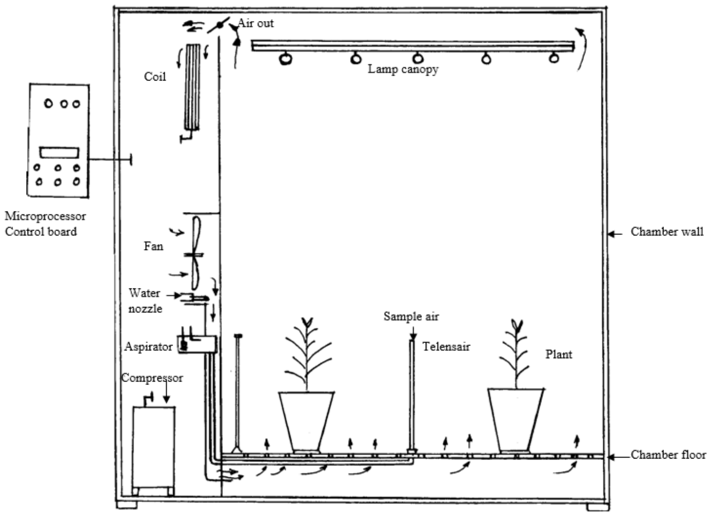

Figure 1. A Diagrammatic view of plant growth chambers

Figure 2. A view of plant samples kept inside the growth chamber in the phytotron

Growing plants within an enclosure inherently include respiration and photosynthesis, the two fundamental physiological processes regulating their growth and development. Carbon dioxide is the typical component active in both these reactions. Therefore, monitoring and managing the carbon dioxide levels is critical for the proper growth management of plants within the chamber. However, CO_2 is one of the minor controllable elements in plant growth chambers. Growth responses to increasing CO_2 levels are hard to detect. Growth chambers often have little exterior air exchange, and the most severe issue is related to the human presence within and occasionally outside the chamber, boosting CO_2 levels. CO_2 - the dependent physiological function may be influenced by short-term changes in CO_2 content. CO_2, an essential component of climate study, is carefully maintained with the aid of the HORIBA CO_2 regulator. It has a range of 50 to 2000 ppm. All plant crops can grow under high carbon dioxide circumstances with accuracy. Greenhouses are used to research seasonal crops. In these semi-regulated experimental settings, light hours may be adjusted per requirement. It can be enhanced in terms of humidity management while they have a more accurate control for temperature as the ideal temperature level can be maintained. Besides, these germinator chambers are also accessible to examine the seed-related factors under specified climatic settings.

Some of the essential parts of plant physiology may be found by phytotron

- Analysis of crop responses against diverse abiotic conditions, including temperature and dryness
- Induction of synchronous flowering, investigation of source-sink connections, and influence of photoperiod variation on crop development
- The seedling-based characterization for varietal identification and purity testing
- Induction of certain features like pigment expression by modification of light and culture conditions
- Analysis of responsiveness to herbicide levels
- Plant nutrient interaction in hydroponics

CONCLUSION

An accelerating approach to improving different food crops has led to controlling environmental research in the recent past where plants can be grown round the year irrespective of the season outside. Phytotron is one such facility that helps the researcher grow plants under artificial environmental conditions to see the plant performance under regulated environmental conditions as per the need of the experiment. In the phytotron, all the environmental conditions can be simulated artificially irrespective of the season outside, giving the necessary boost for accelerating the plant physiological research.

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