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The Climatic Chamber Improvements:

Description and Performances

of a Plant Growth Chamber for Studying

the Eco-physiological Functioning of Tree Saplings

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CONTENT LIST

SUMMARY

This document describes the climatic chamber, and details its performances.

GLOSSARY

None

LIST OF ASSOCIATED DOCUMENTS

None

1 GENERAL OBJECTIVES

This Plant Growth Chamber, named here after Phytotron is intended:

1) to be used as room of culture for the breeding of forest tree saplings for long periods in controlled climatic conditions which can vary on a broad range of climatic parameters;

2) to be used as room of climatic tests to analyse the eco-physiologic responses of the tree saplings to the various climatic parameters: temperature, moisture, illumination and carbon dioxide by using for each parameter the broadest range of possible variation.

In particular this equipment is designed to study on forest tree saplings:
- response to the climatic stresses such as edaphic or atmospheric drought, strong climatic temperatures,
- specific inter and intra- variability,
- stresses induced by the passage of fire on the trunk and the foliage.

It is also design to envisage the effect of the climatic changes.

Concerning specific studies dedicated to the wildland fire impacts on the tree saplings, this device and the experimental benches installed in Les Vignères are complementary.

Trunks of forest tree saplings can be exposed to heat released by a thermal belt, an artificial burner or an experimental fire.

Then, their eco-physiologic parameters may be compared to control trees, under either "normal" conditions or "artificial drought" conditions in order to simulate different climatic post-fire conditions.

The direct impacts can be analysed by protecting trunks or foliage by shelters.

On the opposite, forest tree saplings can be "artificially" stressed in the Phytotron prior to be exposed to heat on the Les Vignères experimental benches.

Their eco-physiologic parameters may be compared before and after the thermal tests, following the procedure indicated here above.

2 CLIMATIC PERFORMANCES

2.1 AIR TEMPERATURE

It is adjustable between 8 and 35°C with an accuracy of, at least 0.5°C.

The increasing or decreasing temperature rate is 10°C per half an hour in average conditions: 15 to 25°C.

2.2 AIR RELATIVE MOISTURE CONTENT

It is adjustable according to the temperature within the limits fixed in the following table:

Air moisture content is measured in the air conditioning box, therefore in absence of lightning.
The increasing and decreasing rates of air moisture content are 10% of moisture content per half an hour in average conditions.

Temperature	10°C	15°C	20°C	25°C	30°C	35°C
Maximum moisture content (1)	90%	90%	90%	90%	85%	65%
Minimum moisture content (2)	70%	45%	35%	25%	20%	15%
Minimum moisture content for tests (3)	< 45%	< 30%	< 25%	< 20%	< 17%	< 15%
Lower limit of minimum moisture content (4)	30%	20%	15%	10%	7.5%	5%

(1) In case of intense radiation (higher than à 750µmol/m²/s), the maximum moisture content is lower by 10% than these values

(2) The normal transpiration of the forest saplings is about 2 kg per hour, when air circulates through the chamber (open state), and with the experimentalist working inside the chamber

(3) The normal transpiration of the forest saplings is about 2 kg per hour, when air is recycled inside the device (close state), and with the experimentalist working inside the chamber

(4) Same conditions as before (3), the normal transpiration of the forest saplings is less than 1 kg per hour

2.3 ILLUMINATION

Maximum illumination is 1000 µmol/m²/s at 90 cm the ground i.e. to 1.60 m of the luminous ceiling .

It is adjustable from 0 to 1000 µmol/m²/s by successive steps.

2.4 CARBON DIOXIDE

CO_2 concentration is adjustable from 150 and 1000 ppm under the following conditions:

- above 320 to 350 ppm, the regulation is efficient, even if the experimentalist is releasing 16 l of carbon dioxide per hour during her/his standard activity,
- below these values, the air breathed by the experimentalist must be collected by a special mask and evacuated by a specific device from the chamber.

2.5 AIR FLOW IN THE CHAMBER

The airflow is horizontal over all the width of the chamber; the air velocity is about 0.25m/s.

Under these conditions, the transverse temperature variation is always lower than 1.5°C, even under conditions of very strong illumination.

3 DESCRIPTION OF THE DEVICE

3.1 NATURE AND DIMENSIONS OF THE CHAMBER

Figure 1-1 presents an outside view of the plant growth chamber

Useful internal surface is approximately 10 m^2 (4 m of depth and 2.5 m of width)

Useful internal height under luminous ceiling is 2.50 m

A swivelling door, with 180°, permits to enter the chamber by a passage of 0.90 m by 2 m.

Horizontal culture tables and large-sized containers can be moved inside and outside the chamber

The door is provided with a occulus with double-glazing and shutter for controlling the functioning of the chamber.

A hopper permits to enter the chamber during climatic tests (particularly low moistures or fixed carbon dioxide concentrations).

The chamber is installed in a building containing five other chambers.

This building contains the infrastructures needed for the experiments:

- 1 an additional laboratory, close to the chamber for complementary tests,
- 2 a storage and preparation area for the substrates and containers; and
- 3 an area in front of the chamber for handling the forest tree saplings in their containers.

Figure 3-1: Phytotron external view
(the hopper is open, the 180° swivelling door is close, left the electric commands)

3.2 AIR TREATMENT

Air is conditioned in a box located in the back of the chamber (not visible on figure 3-1).

It is forced in the chamber through a perforated wall and collected at the opposite wall.

The chamber is equipped by an electric heating.

The cooling production is ensured by a refrigerating unit, cooled by air and placed outside the building.

Air moisture content is obtained using a fogger connected to a demineralised water supply.

A silicagel air dryer dries air; silicagel is permanently regenerated.

Carbon dioxide is provided by tank of compressed gas (50 bars), and extracted by air circulation on soda lime.

3.3 LIGHTNING

Luminous ceiling is composed of lamps of various powers (70 to 1000 W) to obtain homogeneous illuminations at each illumination step.

Lamps have a spectrum adapted to vegetation production, near to the solar spectrum (lamps with metal iodides).

They are placed in a box, outside the "useful" volume, and cooled by fresh air.

3.4 WORKING TABLES AND IRRIGATION

Both tables (3.6 m x 0.85 m) can be moved transversally for permitting the experimentalist to work on one side or between them.

The height of these tables is adjustable between 50 and 85 cm.

These tables can be easily taken outside the chamber for permitting to install higher forest tree saplings in larger containers.

Electromagnetic gates separately control two independent irrigation circuits.

Figure 3-2: Phytotron internal view
Left: temperature, air moisture content, and lightning sensors;
Centre: climatic parameters display (temperature, air moisture content, carbon dioxide concentration and forest tree saplings in plastic bags and containers

3.5 BREATHED AIR COLLECTING DEVICE

It is intended for permitting an experimentalist to work inside the chamber when air moisture content or carbon dioxide concentration is very low.

She/he wares a mask, which collects fresh air from outside the camber and extracts breathed air.

3.6 PERSONNEL SAFETY

For permitting experimentalists to work continuously in the chamber, a safety device equips the chamber for monitoring the oxygen concentration and activating an alarm when it comes lower than 19%.

An other controller of the carbon dioxide concentration is installed outside the chamber, close to the swivelling door.

3.7 AUTOMATISATION AND REMOTE CONTROL

A dedicated software ensures the remote control of the different systems and pilots the chamber.

With this software, the experimentalist can determine the evolution processes of temperature, air moisture content, carbon dioxide concentration, lightning, and irrigation.

Two logic outputs are available for the experimentalist.

She/he can fix height different daily values for each parameter.

The software detects and rejects non-consistent or aberrant values.

The planned improvements concern the performances and the conviviality of the control software ad the remote access to the piloting computer.