

ROBOT WITH GREEN FINGERS

Plant Phenolab is a fully automated platform for investigation of e.g. changes in pigmentation and cells in plants at different treatments, such as contamination with pathogenic organisms. The facility takes care of the following functionalities: watering, fertilization, rotation, randomization and observation of up to 117 plant fixtures.

The Phenolab is built in Taastrup, Denmark, being a proto type for a larger facility which will be built in Frederiksberg, Denmark at a later time.

Watering can take place from 4 different fertilizer mixtures with a precision down to 0.1 ml

Vision Station

Three weights weigh each fixture at least twice a day in order to determine the residue water and increase of biomass. The actual water content in the soil is determined via wireless moisture sensors in the pot.

Each plant fixture contains 1 or 4 plants (in 13x13x13 cm or 8x8x8 cm respectively) Each individual fixture is identified through a RFID-tag

The plant fixtures are moving with a speed of up to 8m/min. and all motions are gentle to the plants

FACTS ABOUT COPENHAGEN UNIVERSITY'S PLANT PHENOLAB

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|---------------------------|--------------------------------------|
| Type | Fully automated phenotyping-platform |
| Length | 12 m |
| Width | 4.5 m |
| Capacity | Up to 117 x 4 plants |
| Maximum plant size | 25 x 25 x 60 cm |
| Speed | 8 m/min. |

The Vision Station is the observation station of the facility. This station contains 2 thermal cameras - one camera placed outside the black box and one placed inside the black box. This enables to observe the surface temperature of the leaves. Using a multispectral camera with LED light source (10 bands from visual light to near infrared light), e.g. the chlorophyll contents and cell changes of the leaves can be observed and quantified. The plants can go through the Vision Station up to twice a day.

The Automation system

This system consists of 13 rows with room for 9 fixtures in each row. The position and orientation of the plants are continuously randomized in order to ensure equal growing conditions for the plants in Phenolab.

Fast Lanes. Selected plants can be conveyed to this place for e.g. manual studies

Kilde: KU, Institut for Plante- og Miljøvidenskab

Robot examines stress sources in plants

Copenhagen University has created a greenhouse where the growing conditions of the plants are automatically analyzed.

ROBOTICS

By Mie Stage mst@ing.dk

"Climate changes may stress crops - but if we have sufficient knowledge about the plants we can adapt the quantity of e.g. water and fertilizer to the given conditions and then we are able to help the plants to the right track. Therefore Department of Plant and Environmental Sciences at Copenhagen University has purchased a robot which is able to survey and take care of plants in a greenhouse under different conditions, so it becomes quickly clear which of the plant's mechanisms are robust - or the contrary", says Svend Christensen. And he goes on:

"The superior idea is that we are able to see how the interplay is between the plant's gens and the

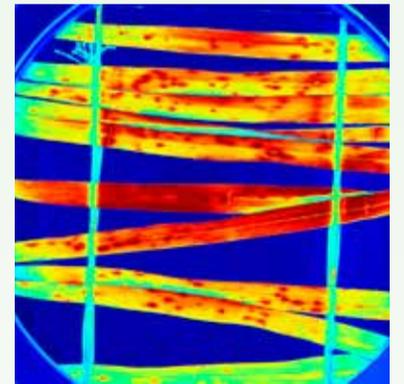
growing conditions.

It is important to find the strains which utilize water and nutrition in the best way so that the plants are able to produce food enough for the world's inhabitants, even under climate stress", says the Department Manager.

The name of the robot is Phenolab and it is developed and produced in a co-operation with the Danish company, ProInvent A/S teknologi-udvikling.

Phenolab is able to look after 117 common potted plants or 468 small plants, and sees to that the plants get water and nutrition according to the regulations which the scientists have decided in advance. At the same time the robot moves the plants in order to give them equal growth conditions at the same time. The robot measures the growth increase and the temperature of the leaves.

By controlling the irrigation levels it is possible to prove how the different strains effectively stand up stress at deficiency of water, and where this character is controlled in the plant's genome. First of all the department wishes to examine barley plants which are infected with fungus mildew in order to find out how the plant as well as the fungus react to different water- and



The above pictures show an examination which can be made in Plant Phenolab. A leaf from 10 different barley plants are infected with the fungus disease barley net blotch, and they are fixed on a horizontal perspex plate. The area in the red stippled square to the right shows a fluorescence image which clearly indicates that the internal growth organs of the fungus have influence on the leaf tissue - even if you cannot see anything with the naked eye. Photo: CU, Department of Plant and Environmental Sciences

nutrient quantities, not at least to investigate if plant breeding is able to make barley plants resistant to the fungus, but also to find out e.g. if more or less rain in the future will change the barley plants' resistance.

We wish to boost the immune system "The plants are examined in the greenhouse but also on the department's test field in Taastrup,

but since wind, weather and different soil types have influence on the growth in the field the greenhouse is very important in order to achieve reliable comparable results, which are not depending on the month July being sunny or rainy", says Svend Christensen. Furthermore we shall use the Phenolab to examine useful micro-organisms which are present in soil

and plants - just like the human bacterial floras - that can help boosting the growth of the plants and their immune system towards diseases.

This is a very exciting area, and till now it has not been examined sufficiently because it requires very precise processing, he says.