University of Münster's new plant research chambers provide prime research conditions

'Controlling every environmental parameter'

The University of Münster (WWU) in Westphalia, Germany recently commissioned six special plant research chambers to facilitate its molecular genetic and cell biology research. These state-of-the-art facilities put the Institut für Biologie und Biotechnologie der Pflanzen at the forefront of Germany's plant research community.

Text: LABinsights | Translation: Word's Worth | Photography: FOODnote

With the new plant research chambers, the biology institute's research facilities have effectively tripled in size to six 12 m² rooms. The old facilities, some of which dated back to the 1960s, were badly in need of replacement. They were cramped, and the environmental controls were outdated and unsuited to the precision standards required for today's plant genetics research.

Stefan Weinl, a researcher at the WWU's Plant Molecular Genetics and Cell Biology research group, praised the new chambers. "These new research facilities will allow us to make strides in our studies of Arabidopsis, our main research project. We're trying to take what we learn from this model plant and transfer it to commercial crops. This is fundamental research. In Arabidopsis, it takes only 8 weeks to go from one generation to the next, while in cash crops like rice, tomato, potato and tobacco, this can easily take a year. For example, if we want to make a crop more drought-resistant, our research starts from the drought-regulating genes in Arabidopsis.

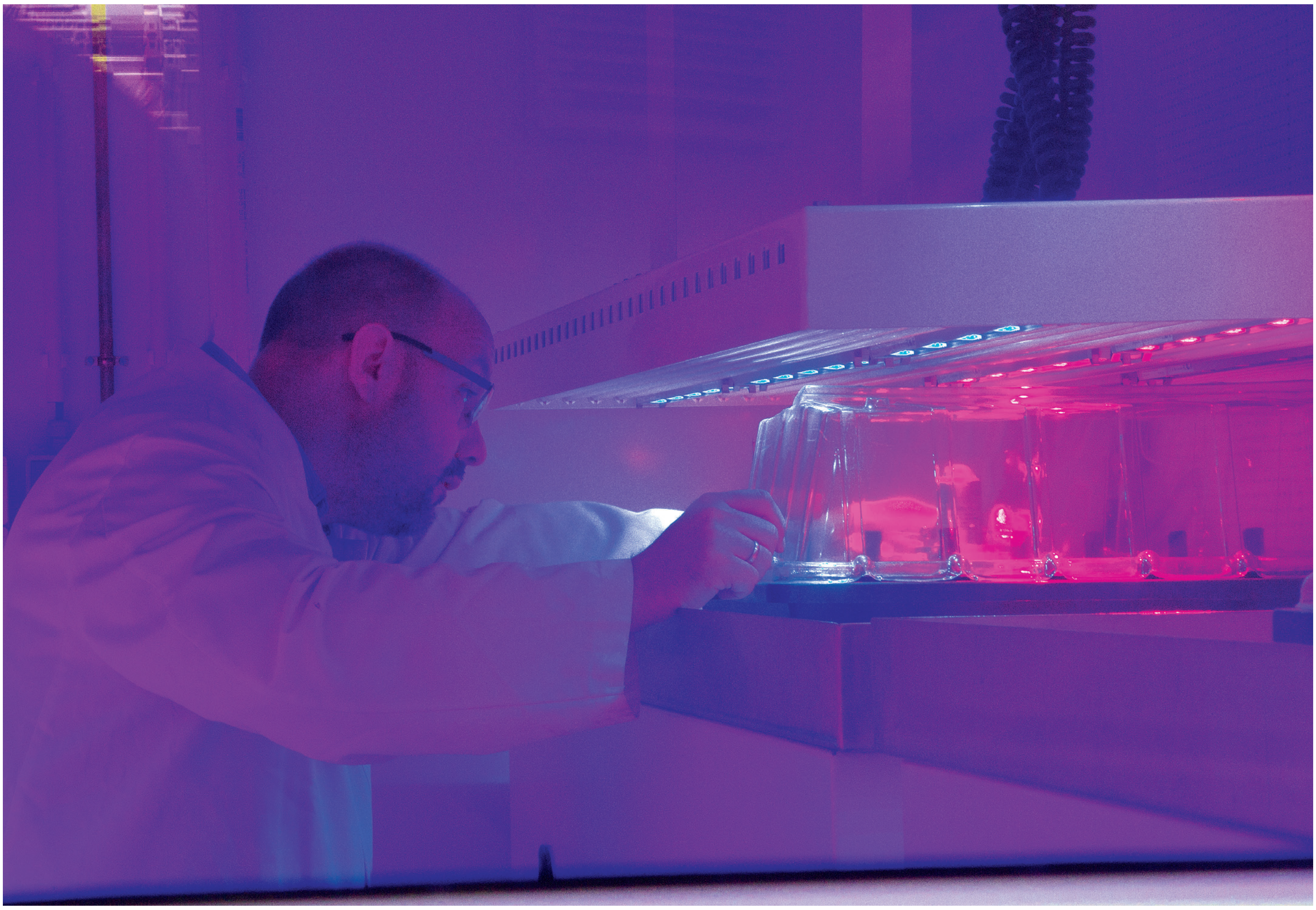
We identify similar drought-tolerant genes in tomato and using biotechnology, replace those with Arabidopsis genes. This speeds up our research tremendously."

Signal paths

All six plant research chambers feature the same climate control capabilities, which gives the researchers flexibility. To measure heat resistance, they can boost the temperature to 50 °C. To test a plant's hardiness, the chambers can be cooled down to -3 °C.

"Plants are much better than animals at adapting to changing circumstances. They have many mechanisms to resist unusually high or low temperatures, or drought and salt stress, which is a problem in dry areas. We look at which signals tell the plants to arm themselves against stressful situations and how they react to environmental changes. Arabidopsis is an ideal model from which we can learn about those signal paths because of its short reproduction time and its limited genome. Which doesn't mean it's easy to grow them in a lab, by the way. They're quite susceptible to root diseases and aphids."

Arabidopsis



Stefan Weinl at the University of Münster Plant Molecular Genetics and Cell Biology research group, in a blue and red LED-lit climate chamber where Arabidopsis's specific light receptors are studied.

'By switching a colored light on or off, we can effectively switch receptors on or off'

Rice research

The light intensity in the chambers can reach a maximum of 1,000 µmol. Walking into a chamber with that much light hurts your eyes. "This is a normal level of light in equatorial areas. Rice won't even bloom if it is not exposed to such intensities." Rice research tends to focus on drought and salt tolerance. The idea is to develop new varieties that are more tolerant of extreme conditions. This will help deal with the effects of climate change, salinization and the pressure on arable land.

To feed the growing world population, we will need to cultivate rice in ever more marginal areas. And in order for rice to grow, it needs to be in a flooded paddy for a certain amount of time. One of the plant growth chambers is equipped to mimic this situation. "We use a table with an extra deep pan, which allows us to automatically flood the roots to a depth of 15 centimeters." Because the plants obviously keep growing during the research, the tables in four of the chambers can be raised and lowered by a lift. "Tobacco and tomato can grow as high as 2 meters, so we need some extra headroom."

Photosynthesis

One room has been equipped with a system to study the effect of different carbon dioxide levels on plant growth. "Air normally contains 400 - 500 ppm carbon dioxide, but in this chamber, we can raise the level to 2,000. This allows us to study how higher concentrations of carbon dioxide affect photosynthesis. The higher the levels, the more growth, we expect." A sign on the wall outside the chamber warns of the suffocation hazard posed by carbon dioxide. At the levels used inside, this is not a realistic danger, but the CO_2 levels are continually monitored anyway, just to be safe. If safe levels were exceeded, an alarm would go off.

Receptors

A porthole offers a view of one of the chambers, bathed in purple light. This space is equipped with blue and red LEDs. Inside, Weinl waters Arabidopsis seedlings with a spray nozzle attached to a garden hose. The plants appear to thrive in the purple light. "This is where we study how special photoreceptors perceive blue and red light. By switching a colored light on or off, we can effectively switch receptors on or off. This allows us to evaluate the effect of different light colors and light intensities on plant growth."

Unprecedented

The climate control systems were designed and built by Bronson Climate. Reliability and control were priorities in Münster University's list of requirements. This is why the cooling system was set up to provide redundancy. Should one of the three compressors fail, the other two can still meet the demand. This ensures that temperatures remain at the set levels. A backup battery keeps the regulating system going in the event of a power cut and prevents the problems associated with restarting the system. In addition, a tiny 0.5 ˚C temperature tolerance is permitted in the climate chambers. This constant climate guarantees the reproducibility of research conditions. "Robustness and reliability were our top two requirements for these chambers," Weinl says. "The technical installations simply cannot fail. Ever. And we wanted to ensure that we could meticulously control the climate. In our old facilities, we were plagued by fluctuating temperatures. The fact that the temperature now remains constant is a great improvement. Just like the wide range and precision of our settings for light intensity, humidity and carbon dioxide levels. We can control every environmental parameter. In that sense, the array of options we have here is virtually unprecedented in Germany. We expect to be able to report our first research results in late 2017."

SPECS

- The plant research facility at the University of Münster (WWU) has six 12 m^2 plant research chambers at its disposal. The chambers were built using 2.9 m Viessmann panels. These are 30 cm higher than standard panels, enabling cultivation of tomato and tobacco, which reach 2 m in height. Four of the chambers have height-adjustable tables. All six have adjustable lighting. The light can be increased to a maximum of 1,000 μmol at a distance of 20 cm, comparable to daytime sunlight intensity near the equator.

- Five of the chambers have been equipped with luminaries containing 22 fluorescent tubes (diameter 16mm, 80W) and two – red and far red – LED modules. One chamber has luminaries containing 20 fluorescent tubes and three – red, far red and blue – LED modules. The LED modules are programmable down to the last micro-mol with a Siemens PLC (Programmable Logical Controller).

- The climate control system is also regulated using PLCs, which are connected to two backup batteries to ensure continued operation when the power is out. Should the power be cut, the PLC automatically switches to the backup power supply. This ensures that the PLC never shuts down abruptly. Shutdown always happens gradually, even in an emergency, so the PLC has time to save all the programmed settings.

- A VPN connection makes it possible for users to remotely monitor the installation, analyze any malfunctions and even optimize its performance. The climate control system uses three air compressors.

- The primary compressor starts at 30 Hz and then increases its RPMs to 60 Hz. The other two compressors run at lower capacity and together are able to provide a full backup. The refrigerant used – glycol – is kept in a 1,500-liter container. The whole system contains 2,200 liters of glycol. It takes one compressor about an hour to lower the glycol's temperature to -6 ˚C, the temperature needed to keep the plant chamber at a steady -3 ˚C.