Humidity Generator and Controller (HGC)

Measuring Contact Angles on Leaves at Different Relative Humidity

According to the German account of the Federal Office for consumerism and food safety (BLV), there are currently more than 1000 official crop protection products and compounds registered for fighting against pests, germs and weed. The ***efficiency of pesticides and their application is of high importance*** *since excess pesticides will pollute the environment and* ***endanger human health****. For pesticide applications the wettability of the biological surface structures, e.g. plant leaves, plays a crucial role which influences the amount of droplet deposition on the plant leaves. Furthermore, the* ***humidity has an important effect on the wetting behaviours of plants surfaces***[1]*. For the development and the optimization* ***of crop protection products****, good wetting and adhesion properties must be guaranteed under different ambient air humidity. The influence of* ***relative air humidity*** *on the wettability of plant leaf surfaces can be studied with a combination of our* ***humidity generator HGC*** *and* ***optical contact angle measuring device OCA****. The following note uses Miscanthus leaves as an example to present this technique.*

Fig. 1. Crop protection product gets sprayed on plant leaves to fight against pests.

Keywords: OCA ▪ HGC ▪ Contact Angle ▪ Relative Humidity ▪ Plant surface ▪ Crop Protection Products

Technique and Method

The humidity generators and controllers of the HGC series (Fig. 2) allow for **a reliable control** of the **relative humidity**, in the range of **5% to 90%**, inside measuring chambers from DataPhysics Instruments or in combination with any other device that requires the precise control of humidity in a measurement chamber. With an integrated pump and desiccant reservoir, the HGC can independently generate a dry airflow using ambient air. Together with the heated water reservoir the desired humidity can be generated.

With the additional humidity and temperature sensor the system can **measure directly at the target location** and calculate the dew point inside of an environmental chamber.

Fig. 2. Humidity generator and controller of the HGC series

The humidity generators and controllers of the HGC series **work as stand-alone devices** and are also **combinable with various laboratory devices and chambers of other manufacturers**, like liquid and Peltier temperature control chambers which allows the research of relative humidity to be carried out at different temperature. Besides, the HGC series is designed to work perfectly with all optical contact angle measuring and contour analysis systems of the **OCA series** from DataPhysics Instruments.

Thus, this technique enables the study the wetting behaviour of plants at different relative air humidity, like Miscanthus leaves in this application note.

Experiment

In this application note the contact angles (CAs) of water on the leaves of *Miscanthus* were determined at different relative humidity utilizing a combination of HGC and OCA.

During the measurements the temperature was kept constant at 25 °C using a Peltier temperature control chamber TPC 160 (temperature range: -30 to 160 °C) (Fig. 3). The relative humidity was set to 20%, 50% and 90% with the HGC. Water droplets were dosed with a volume of 2 µl on the leaf's upper and lower side.

The CAs were analysed automatically by the SCA software. To ensure the accuracy and reproducibility of the results, measurements were carried out three times at each humidity.

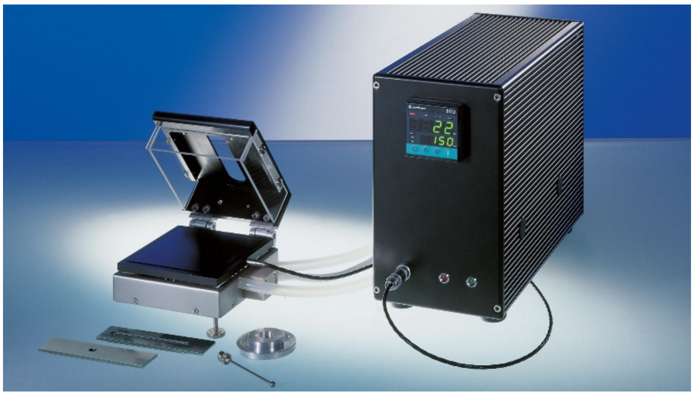

Fig. 3. Peltier temperature control chamber TPC 160

Results

Fig. 4 and Fig. 5 show that the relative humidity influences the wettability of both the upper and lower sides of *Miscanthus* leaves significantly.

The CA values on the upper side are all lower than 80° (Fig. 5) and increased from 58.2° to 79.6° with increasing relative humidity. However, the contact angle decreased to 64.3° when the relative humidity was increased to 90%.

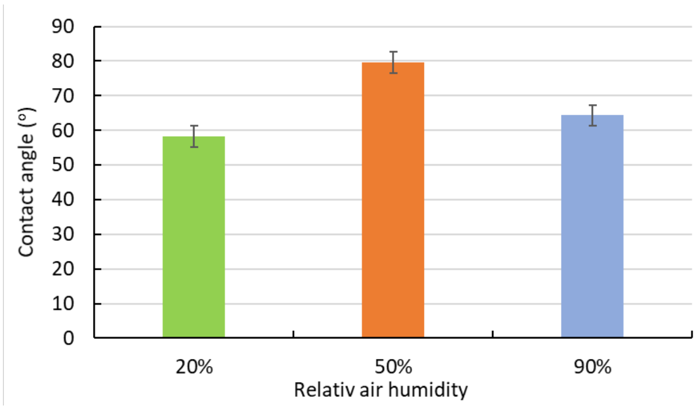

Fig. 4. Contact angles of water on the upper leaf side.

On the lower side all contact angles were higher than 90°. Furthermore, it was noticed that the contact angles increased with decreasing humidity having a maximum of 125.3° under 20% relative humidity (Fig. 6).

The significant difference between the upper and lower side of the leaves is attributed to the leaf anatomy. The top side of the leaves is naturally covered with a wax layer, called *cuticula*, influencing the wettability. Although the lower side of the leaves is also covered with a wax layer, a microstructure is present, so the contact area is smaller than on the top side. Thus, the wettability of the lower side of the leaves is more hydrophobic.

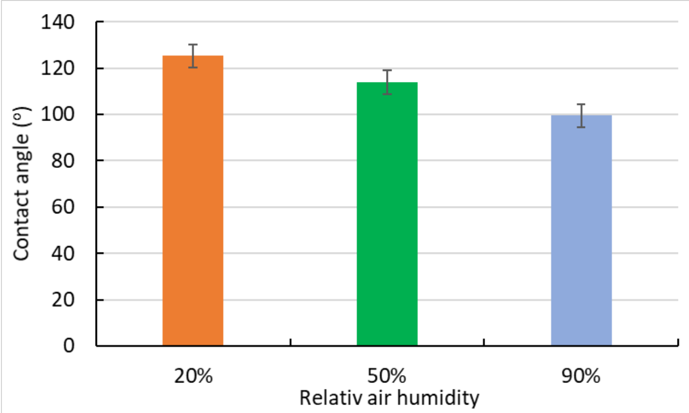

Fig. 5. Contact angles of water on the lower leaf side.

Additionally, the lower the relative humidity, the smaller the influence of the water molecules in the ambient air on the wetting behaviour of the leaves, which can pre-wet and change the surface properties. Therefore, the contact angles on the lower leaf side increased with decreasing relative humidity.

Summary

The optical contact angle measuring device OCA and the humidity generator and controller HGC from DataPhysics Instruments provide an **easy and reliable** way to investigate the **influence of humidity on the wetting behaviour** of plant surfaces, like *Miscanthus* leaves.

This technique can support the development and optimisation of sprayed, liquid crop protection products amongst others.

Literature

[1] Aston, S.; Street-Perrott, A., Doerr, S. (2014): Factors influencing biochar hydrophobicity and the influence of biochar content on the hydrological and erosional response of a silt loam under simulated rainfall. Geophysical Research 16, EGU2014-12472-3.

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