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Wetting Agent Addition for Limiting Risks of Hydrophobicity of Peat Substrate



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Introduction

An important constraint of peat substrates is their hydrophobic character which appears when they undergo a high degree of desiccation. The rewetting duration is then long and the substrate quality is at risk.

To remedy this, the use of wetting agents is already considerably practiced to improve the wettability of these peat substrates, i.e., to avoid these negative impacts for plant growth, and then to improve irrigation management.

More than quick and qualitative tests frequently used, this work aimed to estimate the effects of wetting agents on the wettability of a peat substrate prepared at different initial moisture contents (MC), by using 2 complementary methods, based on two different study-scales:

- a macroscopic and direct qualitative estimation of the rewetting capacity (called hydration efficiency test), developed in NCSU Horticultural Lab. and described by Fields et al. (2014);
- a microscopic approach based on contact angle measurements, developed in Agrocampus Angers, France (Michel et al., 2001).

Materials & Methods

- 1 peat substrate, pure or prepared with wetting agent addition at the recommended concentration (4 fl oz/yd³)
- Samples equilibrated at 4 initial moisture contents (MC): 25%, 37.5%, 50%, and 62.5% (by weight)
- Contact angles determined by capillary rise method (Michel et al., 2001) (Fig. 1, 2)
 - Glass tube with a porous glass base filled with substrate (5 or + replicates)
 - Tube fixed to a micro-balance, then placed automatically in contact with a receptacle containing the liquid (Fig. 1).
 - Speed of capillary rise, translated by the increase in weight of the sample, measured in relation to time by computer, which automatically monitors the Krüss Processor Tensiometer K12®.
 - Contact angles determined using Washburn's equation (1921):

$$\cos \theta = \frac{m^2}{t} \cdot \frac{\eta}{\rho^2 \cdot \sigma \cdot c}$$

t = time (s)
 m = mass of the adsorbed liquid (g)
 η = viscosity of the liquid (mPas)
 ρ = density of the liquid (g.cm⁻³)
 σ = surface tension of the liquid (mJ/m²)
 θ = contact angle between powder and liquid
 c = approximate constant of the porosity and tortuosity of capillaries

- Hydration Efficiency measured by Fields et al. (2014) method (Fig. 3)
 - 4 replicates of 200 mL of each substrate at each MC was packed in a cylinder, then placed in the hydration efficiency unit.
 - A hydration event consisted of passing 200 mL water through the sample and collecting effluent as it came out the bottom.
 - 10 total hydration events were performed for each treatment.
 - Samples were then saturated from the bottom and allowed to drain in order to determine container capacity of the material.

Table 1. Contact angles for peat without and with wetting agent addition equilibrated at initial moisture contents. Standard errors are less than 0.3°

	25 % MC	37.5 % MC	50 % MC	62.5 % MC
Peat without wetting agent	> 90°	> 90°	89.8 °	84.9°
Peat with wetting agent	87.2 °	83.9°	81.3°	76.5°

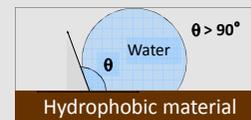
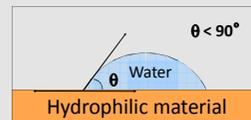
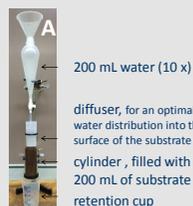
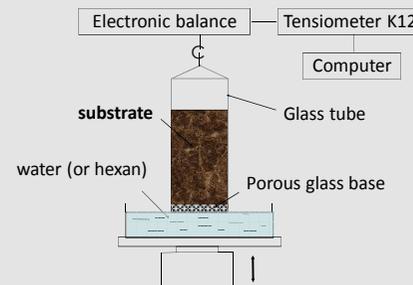


Figure 1. Contact angle on a solid surface



Figure 2. Instrument for determining contact angles on porous material (e.g. substrate)



preferential water flow
hydrophobic zones

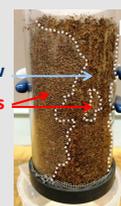


Figure 3. A) Set up of hydration device. B) Cylinder filled with peat substrate (37.5 % MC), showing hydrophobic zones and water preferential flows

Results

Figure 4. Hydration efficiency curves, representing the cumulated volumetric water content after each hydration event. Peat samples were tested at initial moisture contents of 25% (red), 37.5% (purple), 50% (blue), and 62.5% (green). Dotted lines represent container capacity (same set of colors). (Initial bulk density, $\rho=0.115$).



Conclusions

- Peat without wetting agent exhibited hydrophobicity for ≤ 50 % initial moisture contents, which was more and more irreversible with the intensity of drying.
- Peat with wetting agent addition easily rewetted, and recovered a high CC, whatever the initial moisture content, and can be considered as highly hydrophilic.

References

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