Wood fiber as a sustainable peat alternative for reducing risks of hydrophobicity in peat-based growing media.

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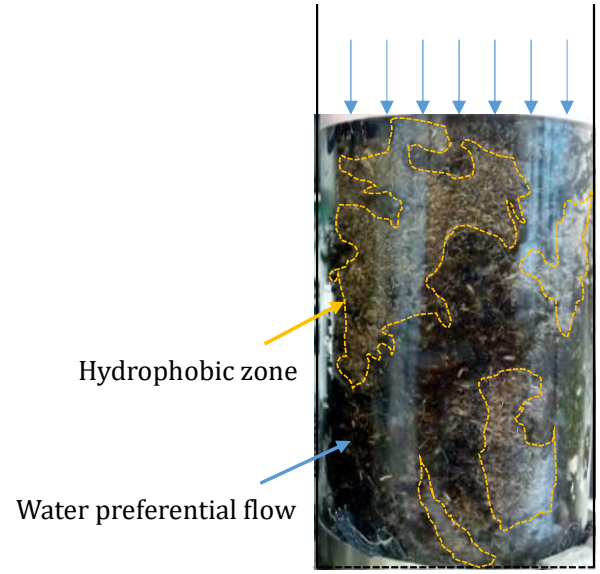


Water preferential flows as a consequence of peat hydrophobicity

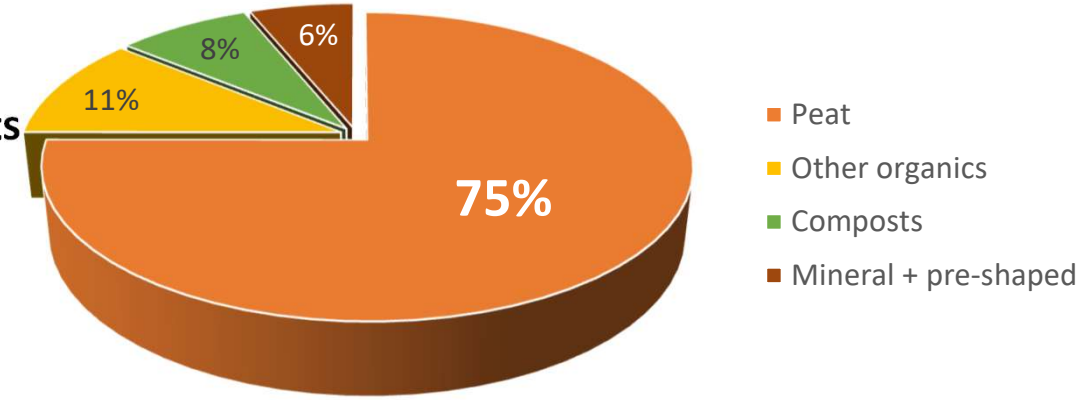
Workshop_Off the peat path

25 April 2023

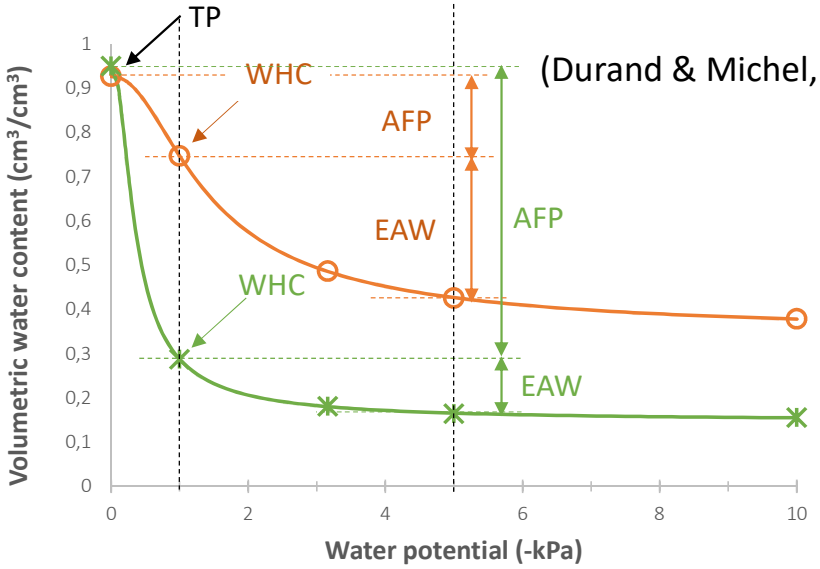
Issues & Challenges

- ***Sphagnum* peats: main growing media constituents**

  Growing media market in Europe: > 37 millions m³/year
  (Schmilewski, 2017)



- **Peat: 👍 water retention properties, physical and biological stability**



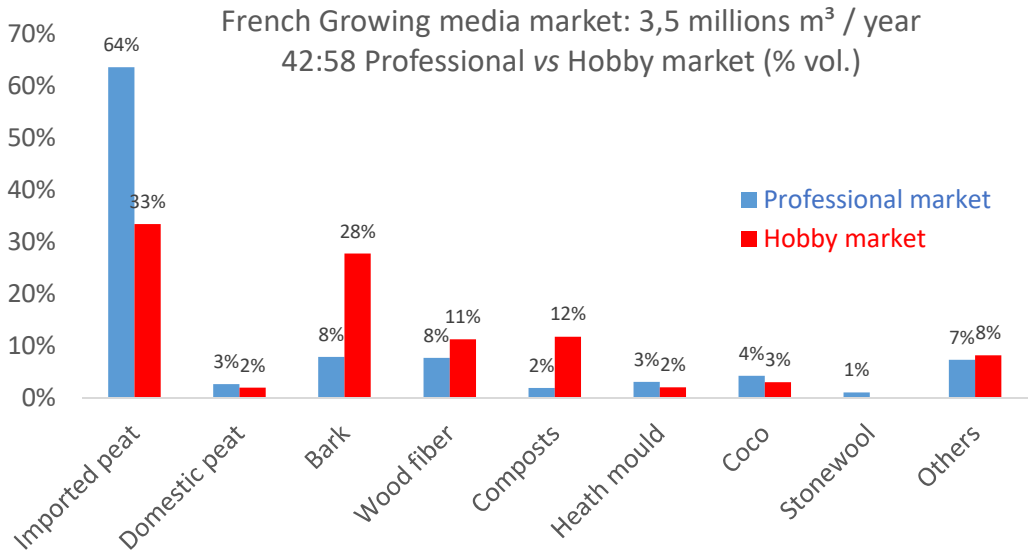
(Durand & Michel, 2021)

	Bulk density g/cm³	Total porosity (TP) v/v	Air-filled porosity (AFP) v/v	Water holding capacity (WHC) v/v	Easy available water (EAW) v/v
Peat	0,12	0,93	0,18	**0,75**	**0,30**
Wood fiber	0,08	0,95	**0,66**	0,29	0,12

Issues & Challenges

- *Peat:* 👎 risk of hydrophobicity during drying
  - ↳ wetting agent or clay addition,
  - ↳ mixes with <u>hydrophilic</u> growing media constituents

- *Peat:* non-renewable (fossil) resource
  - ↳ sustainable (organic) peat alternatives
    - Coir
    - Barks
    - Wood fiber
    - Composts



Study materials

Wood fiber (GreenFibre)

- medium 0-4 mm
- *Picea*
- produced in Germany through extruder
- Dry Bulk Density = 0,08 g/cm^3
- Klasmann-Deilmann

we make it grow

White Sphagnum Peat moss

- milled, star screened 0-25 mm
- H3-H5 Von Post index
- extracted in Lithuania
- Dry Bulk Density = 0,11 g/cm^3
- Klasmann-Deilmann

we make it grow

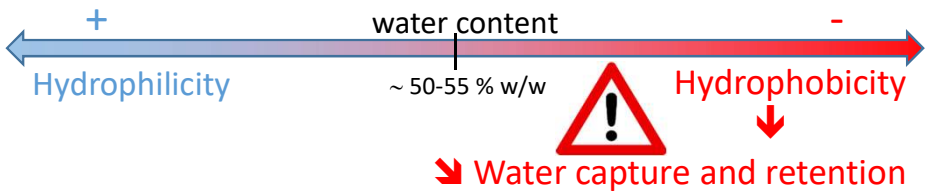
3 initial moisture contents tested, expressed by percent weight (MC) and volumetric water content (WC)

	Dry bulk density g.cm^{-3}	Initial Moisture Content MC by weight (%)		
		40 %	50 %	60 %
		Initial Volumetric Water Content WC (v/v)		
100 %Wood fiber	0.08	0.07	0.10	0.15
60% Wood fiber – 40 % Peat	0.09	0,07	0,11	0,16
40% Wood fiber – 60% Peat	0.09	0,08	0,11	0,17
20% Wood fiber – 80% Peat	0.10	0,08	0,11	0,18
100% White peat	0.11	0.08	0.12	0.19

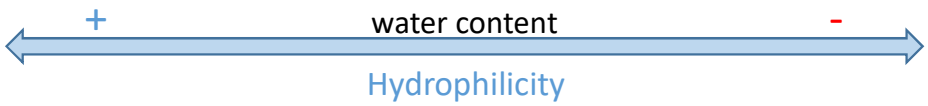
Wettability: 2 types of materials & 2 main methods

2 types of materials

Peat, …



Wood fiber, Coir

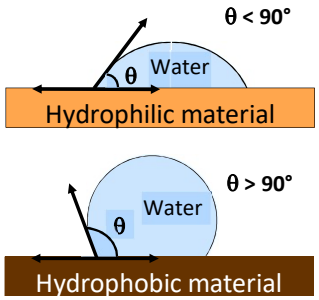


(Michel, 2015; Michel et al., 2001, 2017, 2021; Fields et al., 2014; Schulker et al. 2020; Durand et al., 2021)

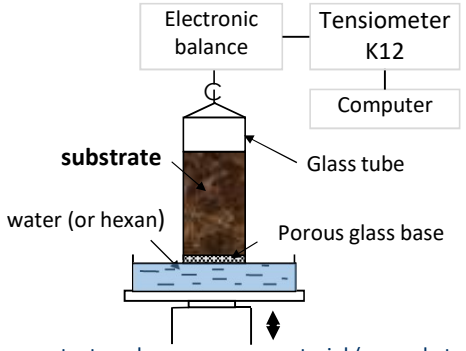
2 main reference methods … differing in study-scale, volumes tested, methods of water delivery

Contact angle ⇨ **capillary rise** (Michel *et al.*, 2001)

microscopic analysis of surface properties of materials



Contact angle on a solid surface



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

Washburn (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)
θ = contact angle
c = approximate constant of the porosity and tortuosity of capillaries
η = viscosity of the liquid (mPas)
ρ = density of the liquid (g.cm^{-3})
σ = surface tension of the liquid (mJ/m^{-2})

Hydration Efficiency test ⇨ **drip irrigation** (Fields *et al.*, 2014)

macroscopic & direct estimation of the rewetting capacity

Set up of hydration device

Contact angle measurements

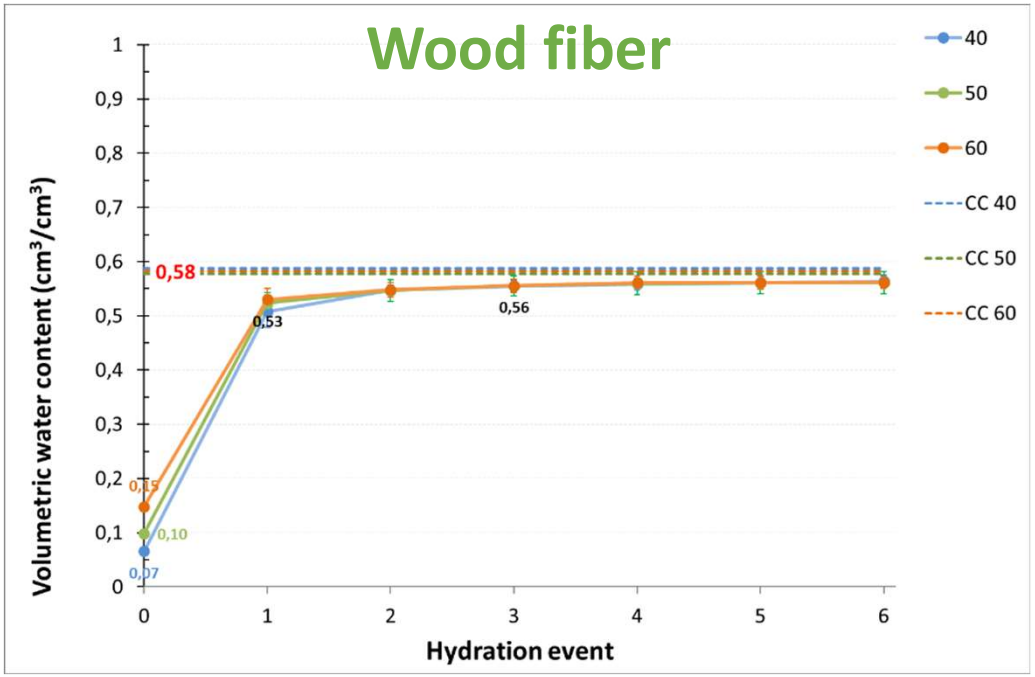
Contact angle (°)	Moisture content (by mass)		
	40 %	50 %	60 %
100% White peat	> 90 (*)	> 90 (*)	87,0
20% Wood fiber – 80% Peat	> 90 (*)	89,4	86,9
40% Wood fiber – 60% Peat	89,7	88,5	86
60% Wood fiber – 40% Peat	89,5	88,1	85,7
100 %Wood fiber	86.1	85.8	85,5

(*) no capillary rise for hydrophobic materials: contact angle varies between 90° and 180°

- **Peat** changes from a **hydrophilic** (60%) to a **hydrophobic** (≤50%) character during drying.
- **Wood fiber** remains **hydrophilic**, whatever its moisture content.
- **Wood fiber** addition in **peat**-based growing media increases its wettability.

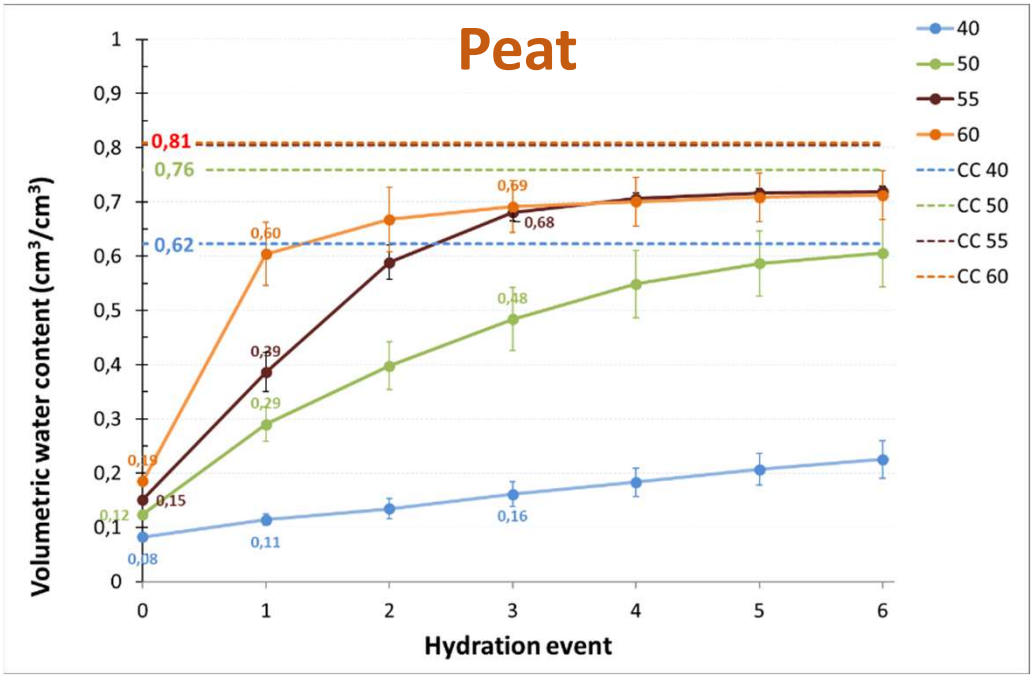
Hydration Efficiency tests

Wood fiber



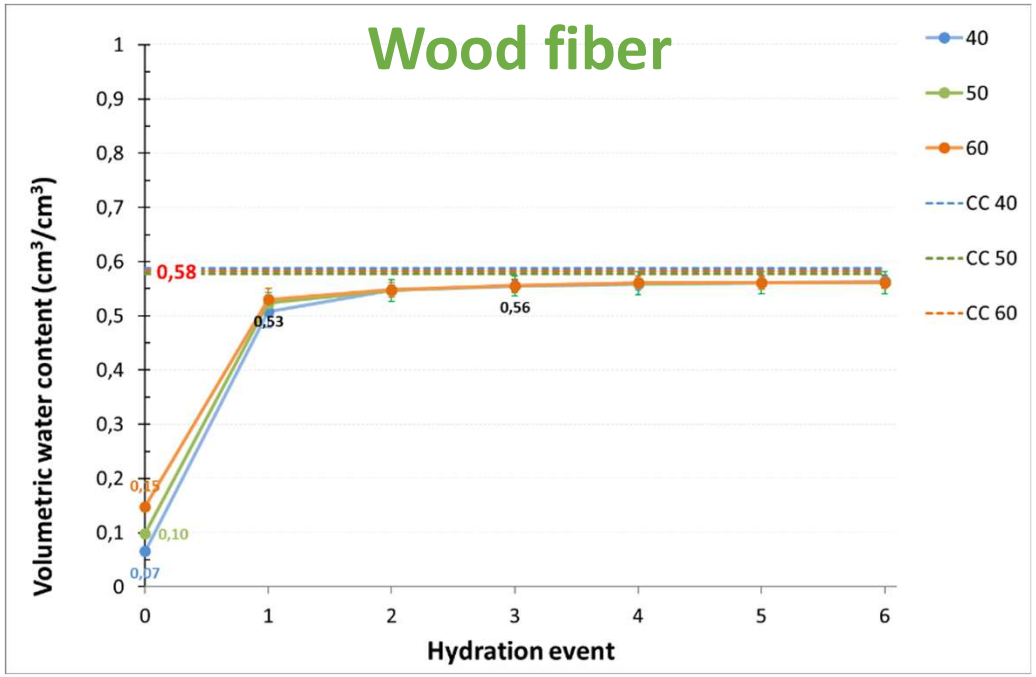
	40%	50%	60%
Water content after the 1st irrigation event, WC_1 (% vol.)	0,51	0,52	0,53
Maximum water retention = Container Capacity, CC (% vol.)	0,58	0,58	0,58
WC_1/CC_{MAX}	0,88	0,90	0,91

Peat



	40%	50%	60%
Water content after the 1st irrigation event, WC_1 (% vol.)	0,11	0,29	0,60
Maximum water retention = Container Capacity, CC (% vol.)	0,62	0,76	0,81
WC_1/CC_{MAX}	0,14	0,36	0,74

Hydration Efficiency tests



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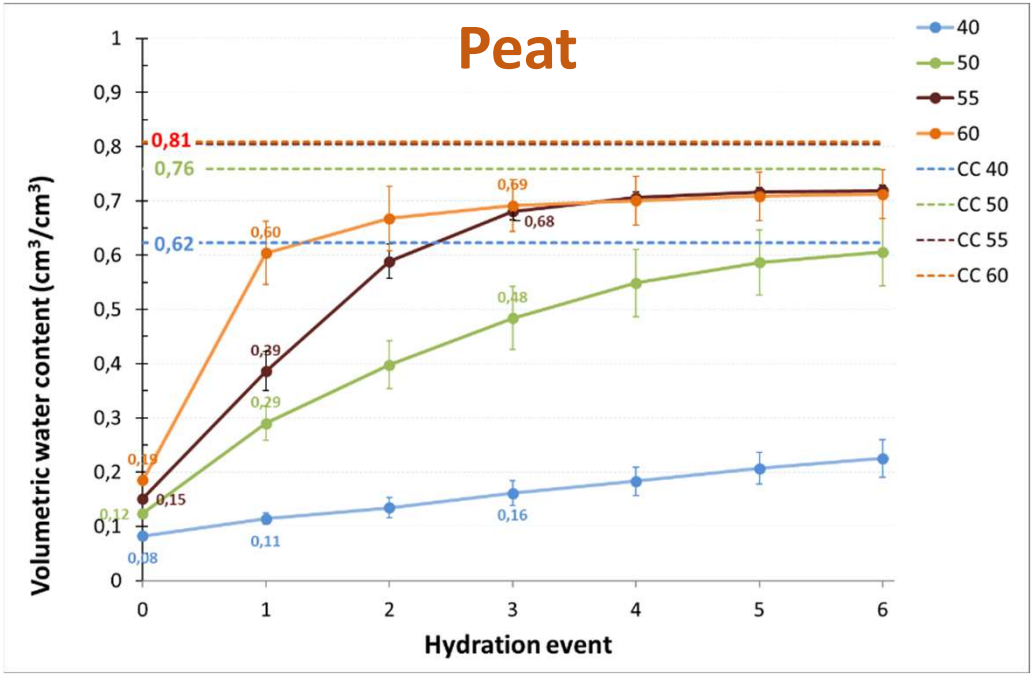
WC_1/CC_{MAX}	**0,88**	**0,90**	**0,91** 👍

- Water capture for **wood fiber** does not depend on initial moisture content: $WC_{40} = WC_{50} = WC_{60}$
- Water retention properties for **wood fiber** are maintained, whatever the intensity of drying: $CC_{40} = CC_{50} = CC_{60}$
- **Wood fiber** remains hydrophilic, whatever its moisture content.

Hydration Efficiency tests

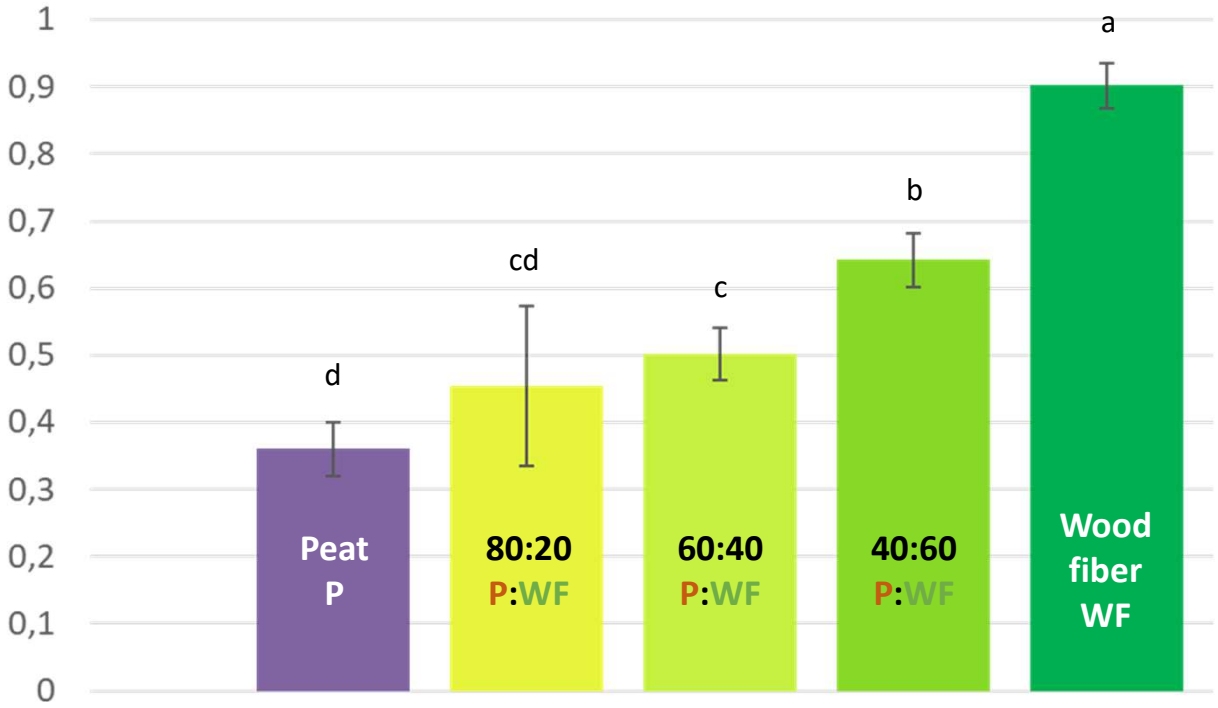
- Water capture for **peat** depends on initial moisture content: $WC_X = f$ (initial moisture content)
- The drier the **peat**, the more difficult its total rewetting $CC_X = f$ (initial moisture content)
- **Peat** changes from a hydrophilic to a hydrophobic character during drying



	40%	50%	60%
Water content after the 1st irrigation event, WC_1 (% vol.)	0,11	0,29	0,60
Maximum water retention (Container Capacity, CC) (% vol.)	0,62	0,76	0,81
WC_1/CC_{MAX}	0,14	0,36	0,74

Influence of wood fiber content on water capture for peat-based mixes

Water capture (% vol.) /
Maximum water retention (% vol.)



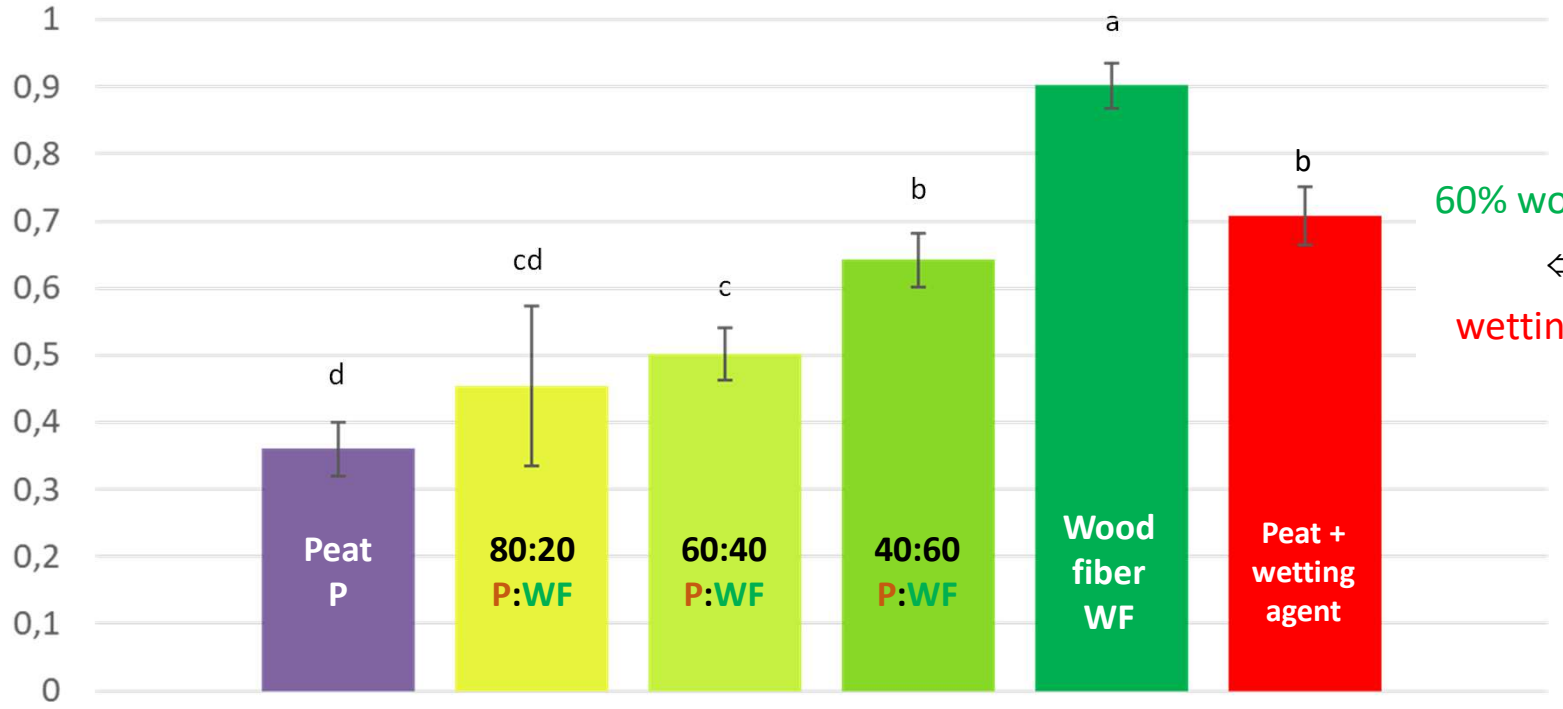
↗ % wood fiber

⇔

↗ rewetting capacity

Initial moisture content = 50% by weight

Influence of wood fiber content on water capture for peat-based mixes: comparison with wetting agent



60% wood fiber ⇔ wetting agent

Initial moisture content = 50% by weight

Main conclusions

- **Wood fiber** is hydrophilic and can be easily rewetted, whatever its degree of desiccation.
- **Wood fiber** addition in **peat-based mixes** increases their ability to rewet (**higher water capture**) despite a **lower water holding capacity**.
- **Wood fiber** addition therefore reduces the risk of hydrophobicity for peat-based growing media.

	Water content after a 1st irrigation event, WC_1 (% vol.)	Maximum water retention = Container Capacity, CC (% vol.)
100% White peat	29	76
20% Wood fiber – 80% Peat	35	74
40% Wood fiber – 60% Peat	38	74
60% Wood fiber – 40% Peat	45	71
100 %Wood fiber	52	58

Initial moisture content = 50% by weight

Wood fiber: Strengths & Weaknesses

+

- **Hydrophilic** ⇨ ↗ **ability to rewet** for peat-based growing media
  - ≈ coco
  - < wetting agent (except in high content)
- **Sustainable, highly available, low cost** resource
- **Complementarity** between aeration properties of **wood fiber** and water retention properties of **peat**

-

- ↗ % **wood fiber** in peat-based mixes **decreases water holding capacity** and **easy available water**

	Total porosity % vol.	**Air filled porosity** % vol.	**Water holding capacity** % vol.	**Easy available water** % vol.
Peat	93	17	75	**30**
Wood fiber	92	52	41	**12**

Optimum (Rivière, 1991) : Air filled porosity > 20% vol. ; Easy available water > 25% vol.

Constituents	**2017**		**2050**		**Increase (vol)**
	Millions $m^3.year^{-1}$	Market %	**Millions $m^3.year^{-1}$**	Market %	
Peat	**40**	59.3	**80**	28.3	**x 2**
Wood fiber	**3**	4.4	**30**	10.6	**x 10**

Wood fiber as a sustainable peat alternative for reducing risks of hydrophobicity in peat-based growing media.

Thank you for your attention

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Water preferential flows as a consequencesof peat hydrophobicity