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## Organic growing media and organic fertilizer's chemistry drive microbial catabolic functions in soilless horticulture.

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## drive microbial catabolic functions in soilless horticulture

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### CONTEXT

Consumer demand for healthy products as well as concerns over agricultural impacts on the environment encourage the development of sustainable practices by producers. This pressure leads to a diversification of Growing Media (GM) and fertilizers in favor of **sustainable organic materials** [1].


Despite GM being widely used, little is known about microbial communities [2]; even less about **microbial functions involved into mineralization** of organic fertilizer [3].

### Objective

**How organic fertilization does affect microbial catabolic functions in growing media ?**

GM physical properties associated with fertilizer chemistry (N content and quality) are suspected as key drivers of microbial functions.

### EXPERIMENT

Growing Media	Fertilizers	300 mg N L <sup>-1</sup>	C:N	C:P
PEAT	HORN		3.3	17
COIR	Granular F1 <sup>a</sup>		5.5	25
BARK	Granular F2 <sup>a</sup>		13.8	72

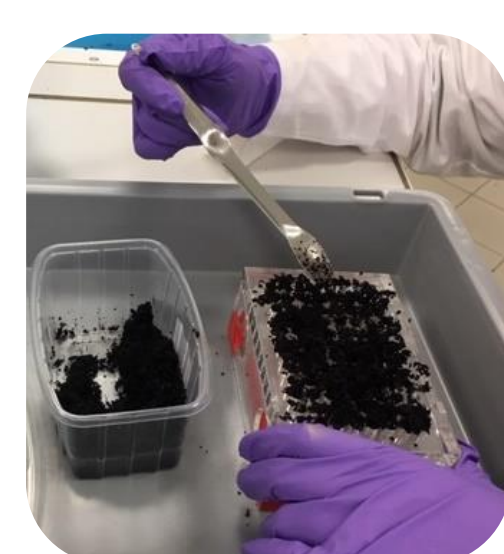
<sup>a</sup> plant based granular fertilizers: commercial names are confidential

**INCUBATION**  
(25°C, 60% of water holding capacity)

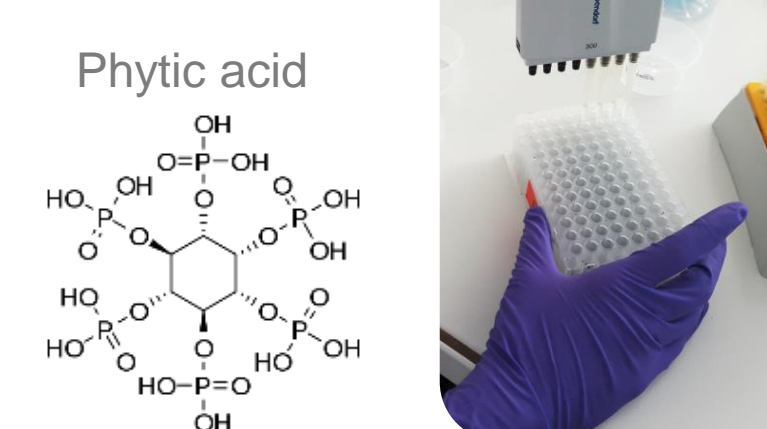
### Toolbox: MicroResp™

Campbell et al. (2003)

#### 1 Filling the Deep-well with the sample



#### 2 C-, N-, P-sources addition



#### C- Sources: from saccharides to aromatics

**Monosaccharides:** D-Glucose C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>, D-Galactose C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>, D-mannose C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>, L-Arabinose C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>, D-xylose C<sub>5</sub>H<sub>10</sub>O<sub>5</sub>  
**Diholiosides:** D-Cellobiose C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>, D-saccharose C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>  
**Acids:** DL-acide malique C<sub>4</sub>H<sub>6</sub>O<sub>5</sub>, acide ellagique C<sub>14</sub>H<sub>8</sub>O<sub>6</sub>  
**Aromatic compounds:** 4-Acide hydroxybenzoïque C<sub>7</sub>H<sub>6</sub>O<sub>3</sub>, catéchol C<sub>6</sub>H<sub>6</sub>O<sub>2</sub>

#### N- Sources: Amino-acids and Urea

L-Lysine C<sub>6</sub>H<sub>14</sub>N<sub>2</sub>O<sub>2</sub>; D-Alanine C<sub>3</sub>H<sub>7</sub>NO<sub>2</sub>; Glycine C<sub>2</sub>H<sub>5</sub>NO<sub>2</sub>; N-acétyl-D-glucosamine C<sub>8</sub>H<sub>15</sub>NO<sub>6</sub>; Urea CH<sub>4</sub>N<sub>2</sub>O

#### P- Sources

Calcium Phosphate (rock phosphate) CaHPO<sub>4</sub>  
 Phytic Acid C<sub>18</sub>H<sub>32</sub>O<sub>24</sub>P<sub>6</sub>

#### 3 Detection plate reading: before and after incubation



#### 5 Incubation – 6h, 25°C – of the device sealed by metal clamp

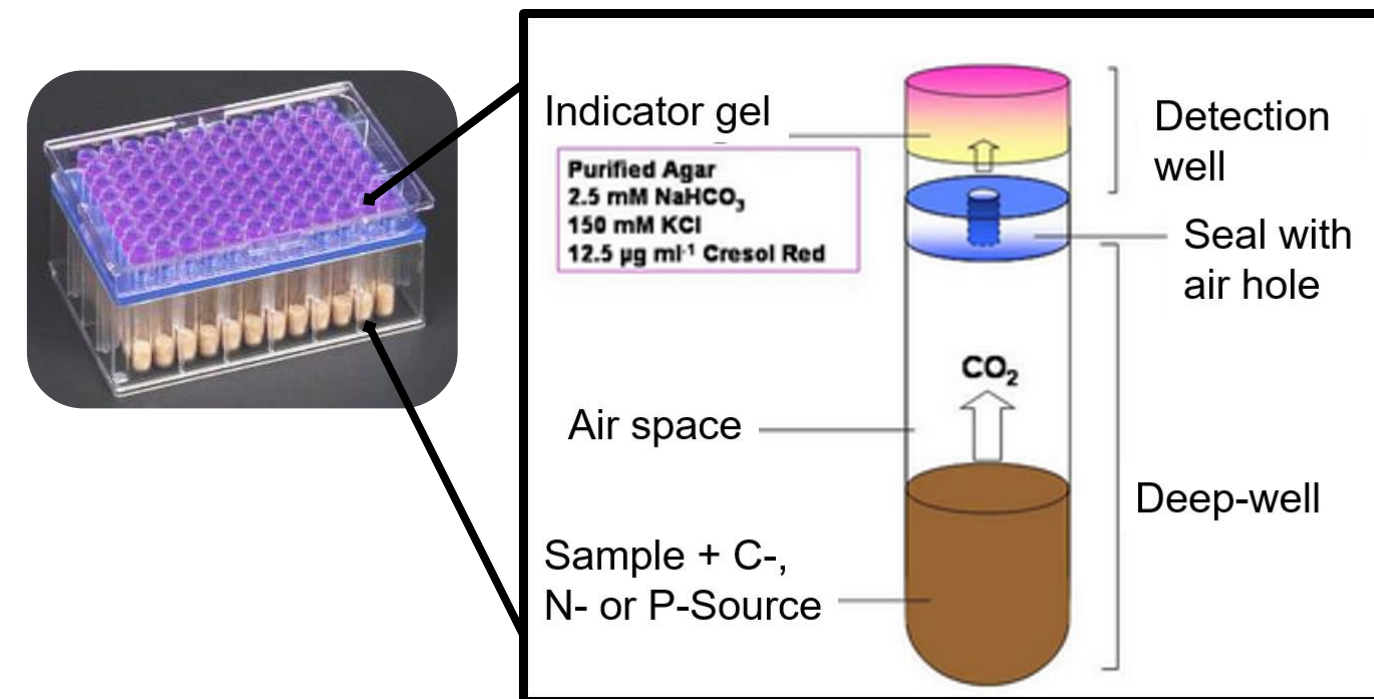


#### 6 Color changes related to % CO<sub>2</sub> produced



Calculation of Substrate Induced Respiration (SIR) rates (mg CO<sub>2</sub>-C L<sup>-1</sup> h<sup>-1</sup>)

#### 4 Assemblage of MicroResp™ device



### RESULTS

#### N limitation in Growing Media

Higher respiration rates:  
 ❖ With N-sources  
 ❖ Mostly in Bark

Phytic Ac.  
 Ca. Phosphate  
 N-ac.-D-gluc.  
 Hydroxy. Ac.  
 Ellagic Ac.  
 Malic Ac.

Phytic acid  
 Calcium Phosphate  
 N-acetyl-D-glucosamine  
 Hydroxybenzoic acid  
 Ellagic acid  
 Malic acid

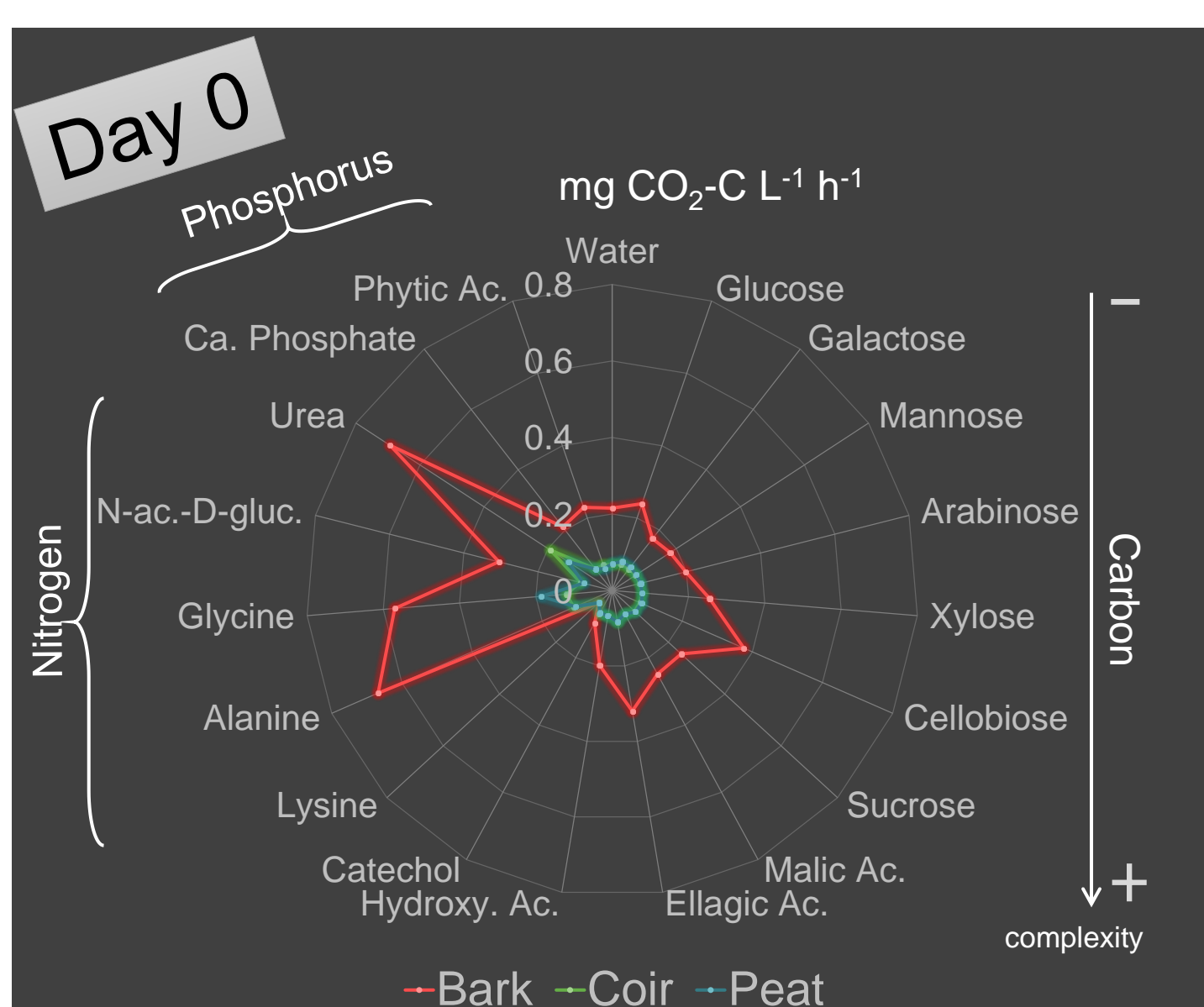


Fig.1: Catabolic Level Physiological Profiles (CLPPs) in different GM, prior to fertilizer addition.

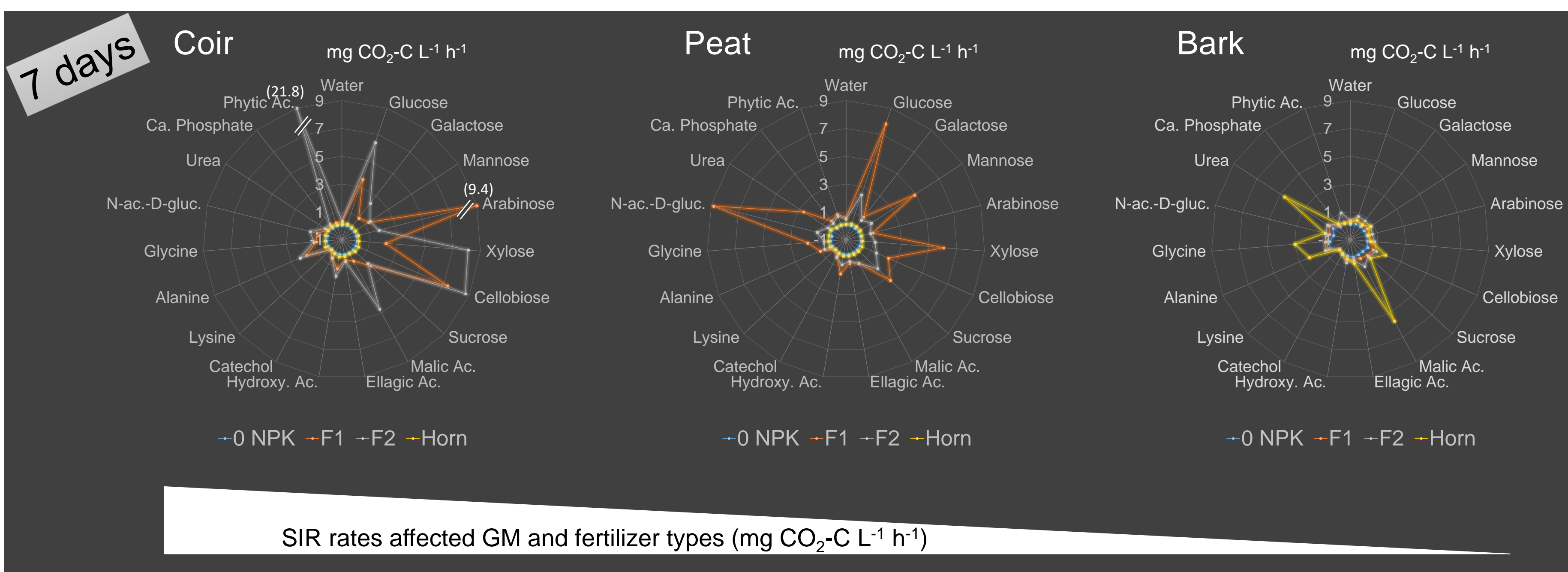


Fig.2: CLPPs after 7 days of incubation

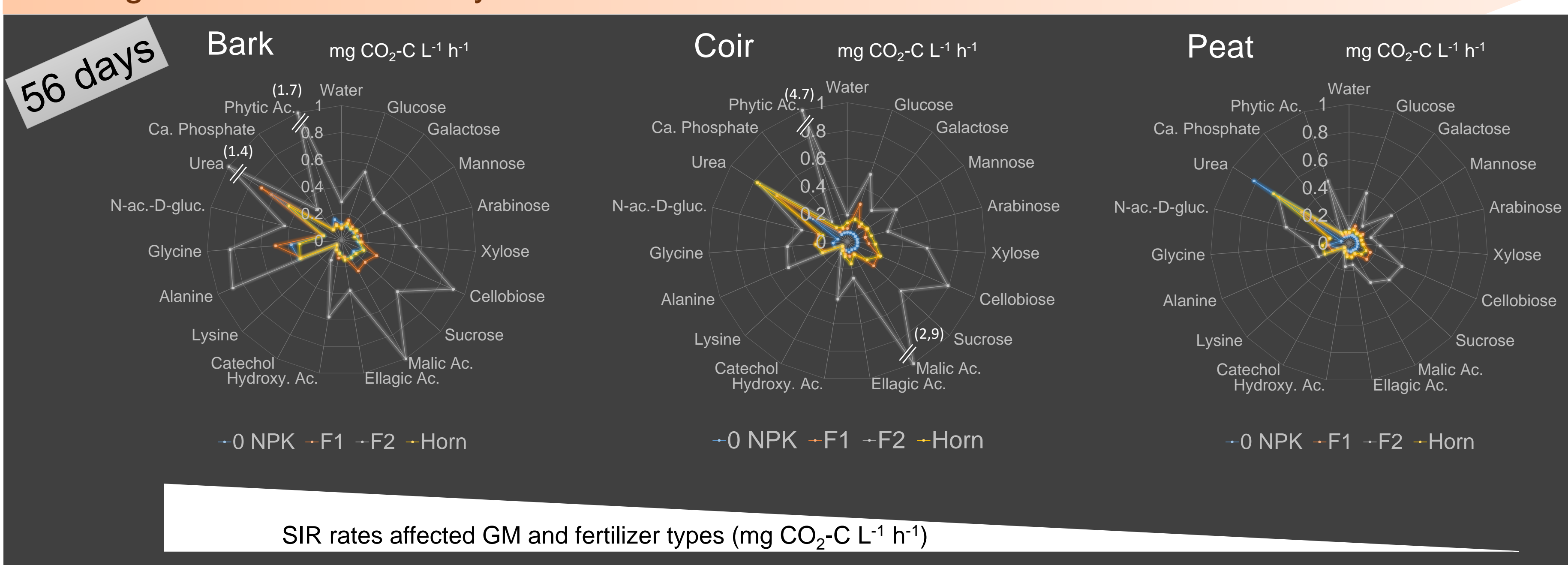


Fig.3: CLPPs after 56 days of incubation

- ❖ SIR rates highly increased after 7 days and slowed down after 56 days: 10 to 1 fold ratio for both coir and peat and 3 to 1 fold for bark
- ❖ SIR rates after 7 days: Coir > Peat > Bark
  - Coir: C induced respiration with F1, C and P induced respiration with F2
  - Peat: C induced respiration with F1 and F2
  - Bark: N induced respiration with Horn
- ❖ SIR rates after 56 days: GM had similar CLPPs but with different intensities (Bark > Coir > Peat)
  - F2 induced highest SIR (C, N and P)
  - Weak effect with both F1 and Horn

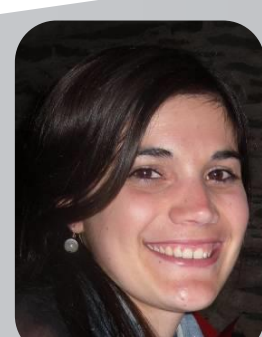
### Discussion and conclusions

- ❖ Fertilizers turned on microbial activity depending on GM
  - The burst in SIR after 7 days in Coir and Peat indicates a strong C-demand (or C-capacity), especially for simple compounds (saccharides).
  - Microbes in Bark are more prone to degrading recalcitrant C-forms (e.g. Horn).
- ❖ CLPPs showed contrasted microbial C, N, P use efficiency depending on fertilizer type
  - Higher SIR intensities with F2: N and P were limited after 56 days (higher C:N and C:P ratios vs. F1 or Horn). The need for P was especially high in Coir.
  - After 56 days, fertilization no longer affects CLPPs reflecting a return to the physiological state of microbial communities.

### Take-Home

- Community Level Physiological Profiles provide deep information on microbial C, N, P use efficiency
- All GM are initially N-limited (Bark > Coir = Peat)
- F2 Fertilizer induces higher microbial catabolism to get nutrients
- Peat and Coir respond strongly to fertilization
- Bark specifically degrade recalcitrant fertilizer

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