





Exchange event between the European phenomic community and industry

Progress on novel techniques and methods for environmental and plant measurements

Xavier Draye (UCLouvain, Belgium)











Part I – Proper environmental characterization in phenotyping experiments is a cost-effective way to turn nuisance effects into benefits

- Spatial and temporal variability in statistical analysis
- Feed plant/canopy/plot <u>dynamic variables</u> into models
- Assemble <u>phenotype-rich datasets</u> from complementary platforms
- Combine similar datasets from different platforms (<u>repeatability</u>)
- Re-use existing data

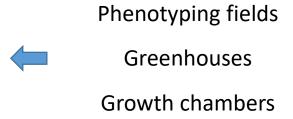




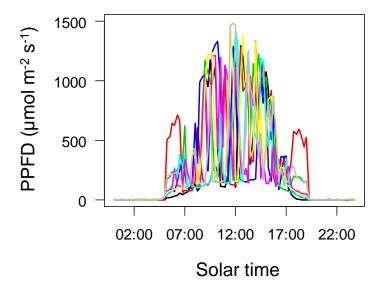


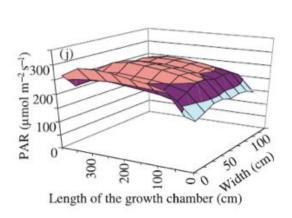












Granier et al 2006

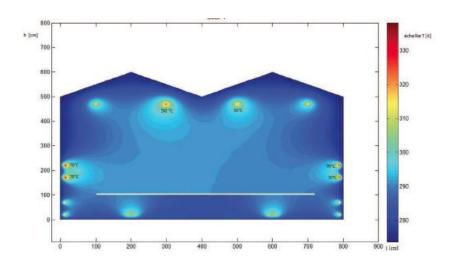




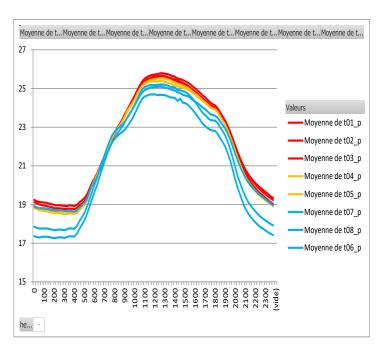








Air temperature (°C)



Hour

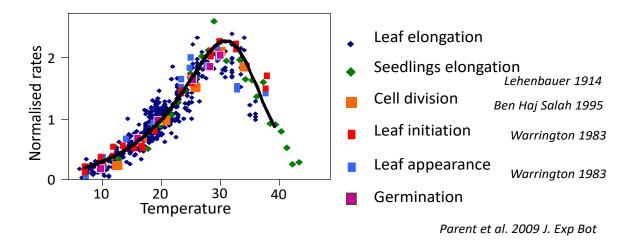


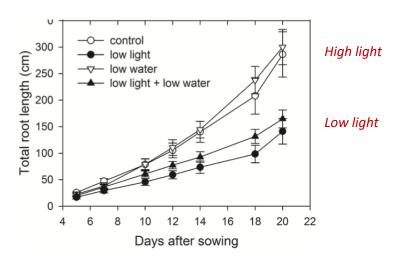
Phenotypes respond to local climate in PP



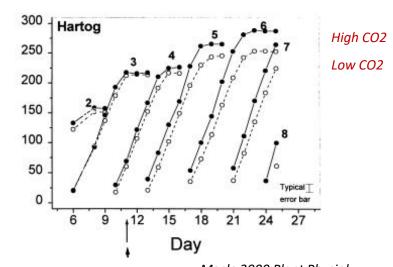








Nagel et al. 2015 J. Exp. Bot.



Masle 2000 Plant Physiol













Option 1: control (platform design, hard to change)





Option 2: monitor (experiment management)

Option 3: do nothing (and sign the death certificate...)









Strategy

Step 1 – Agree on targets

Level 1 (awareness of heterogeneity) – Year 2

Level 2 (maps) – Year 5

Step 2 – Monitor progress of individual platforms

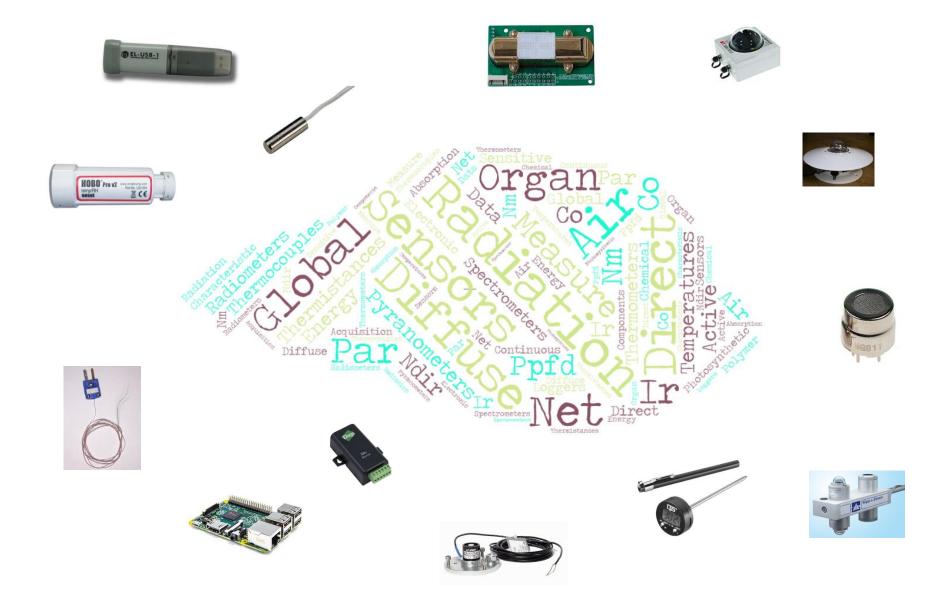
2					- (- 1	Location in	Number of sensors	00 0	Data	
	Installation	Country	Last update	Parameter	Type of sensor	Ų	Units	4	installation	in installation	(hh:mm)	transfer	Storage
3	4PMI	France	03-2020	Light	PAR sensor	¥	umoles/m2.s	*	Inside (fixed)	50	00:005	Wireless *	Database
4	4PMI	France	03-2020	Air temperature	Thermistance	*	°C	*	Inside (fixed)	10	0:05	Cable *	Database
5	4PMI	France	03-2020	Air temperature	Thermocouple	*	°C	~	Inside (fixed)	50	0:05	Wireless *	Database
6	4PMI	France	03-2020	Air humidity	Humidity sensor (capacity)	₩	%	~	Inside (fixed)	10	0:05	Cable *	Database
7	Pheno3C	France	03-2020	Light	Pyranometer	₩	W/m2	₩	Outside	2	0:15	Cable *	Text files
8	Pheno3C	France	03-2020	Light	PAR sensor	¥	umoles/m2.s	~	Outside	2	0:15	Cable *	Text files
9	Pheno3C	France	03-2020	Light	Diffuse / Direct sensor	*	umoles/m2.s	₹	Outside	2	0:15	Cable *	Text files
10	Pheno3C	France	03-2020	Air temperature	Other	*	°C	~	Outside	5	0:15	Wireless *	Text files
11	Pheno3C	France	03-2020	Air temperature	Thermistance	*	°C	~	Outside	2	1:00	Wireless *	Database
12	Pheno3C	France	03-2020	Air humidity	Humidity sensor (capacity)	*	%	₩	Outside	5	0:15	Wireless *	Text files
13	Pheno3C	France	03-2020	Air humidity	Humidity sensor (capacity)	*	%	¥	Outside	1	1:00	Wireless *	Database
14	Pheno3C	France	03-2020	CO2	CO2 Sensor	¥	ppm	~	Outside	8		Cable *	Text files
15	Pheno3C	France	03-2020	Organ temp.	Thermocouple	*	°C	₩	~	10	0:15	Wireless *	Text files
16	Pheno3C	France	03-2020	Soil humidity	TDR	₩	m3/m3	Ŧ	Outside	72	0:15	Cable *	Text files
17	Pheno3C	France	03-2020	Soil humidity	TDR	~	m3/m4	Ŧ	Outside	120	1:15	Wireless *	Text files
18	Pheno3C	France	03-2020	Soil temperature	Thermistance	*	°C	*	Outside	72	0:15	Cable *	Text files
19	Pheno3C	France	03-2020	Soil temperature	Thermistance	*			Outside	120	1:15	Wireless *	Text files
20	Pheno3C	France	03-2020	Wind	Sonic	*	m/s	Ŧ	Outside	1	0:15	Cable *	Text files
21	Pheno3C	France	03-2020	Wind	cup	*	m/s	-	Outside	1	1:00	Wireless *	Database
22	Pheno3C	France	03-2020	Rain	Gauge	*	mm	Ŧ	Outside	12	0:15	Wireless *	Text files



















	А	В	С	D	E	F	G	
1	Go to sensors (fo	Conductivity						
2	Air humidity	<u>Light</u>						
3	Air pressure	Rain						
4	Air temperature	Soil moisture						
5	<u>CO2</u>	Wind speed						
6	Parameter	Type of sensor	Brand	Model + link to doc	Price	Installation	User feedback	
72	Light	Quantum senso	Licor	LI-190 and LI1400		Phenovator		
73	Light	Quantum sensor	Skye Instruments	SKP 215		Phenoarch + Phenopsis		
74	Light	Quantum sensor	Licor	<u>Li 190SA</u>		GS-Rhizo (A-HTR-R2) + G	S-Chambers + B	
75	Light	QuantumSensor	Apogee	SQ-212 PAR		ALSIA		
76	Light	QuantumSensor	Aria Horticulture	SD-PAR-2500u.E		RootPhAir		
77	Light	QuantumSensor	Skye	SKP 215		Pheno3C + PhenoArch +	Phenodyn	
78	Light	spectrometer	Licor	<u>Li-180</u>		Hounsfield		
79	Light	spectrometer	PSI	SpectraPen mini		MTA		
80	Light	Spectrometer	Newport	OSM2-400UV/VIS-U		ExpoSCREEN + SunSCRE	EN	
81	Light	UVB Meter 🔻	Gigahertz-Optik	Radiometer Messkopf UV 3	<u>702</u>	ExpoSCREEN		
82	Light	UVB Meter 🔻	Deka Sensor + Teo	<u>DK-UVB</u>		SunSCREEN		
83	Light		<u>CambridgeHOK</u>			NPCC_Lemnatec		
84								
85	Rain	Rain gauge	Young	<u>Pluvio 52203</u>		Pheno3C		
86	Rain	Heated rain gauge	Young	<u>Pluvio 52202</u>		Pheno3C		
87								
88	Soil Moisture	Humidity sensor (capacity)	Decagon	<u>EC-5</u>		Growscreen + BreedFAC	E	
89	Soil moisture + te	mperature	Campbell Scientif	<u>CS655</u>		Pheno3C		
90	Soil Temperature	Digital thermometer	Dallas	<u>DS18B20</u>		Growscreen + BreedFACE		
91								
92	Wind speed	Sonic	Gill instrument	Windsonic 4		Pheno3C		









Tools and methods (Level 2)

Step 1 – Test / develop

Step 2 – Deploy

- 1. Maps of temperature (GH)
- 2. Maps of light (GH)
- 3. Maps of CO2 (FACE)







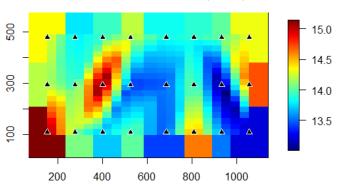




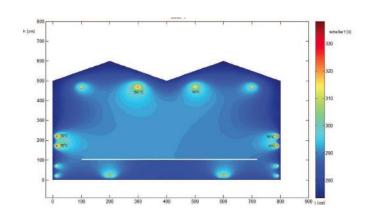




Spatial interpolation Grid of sensors (IoT)



Modelling GH climate

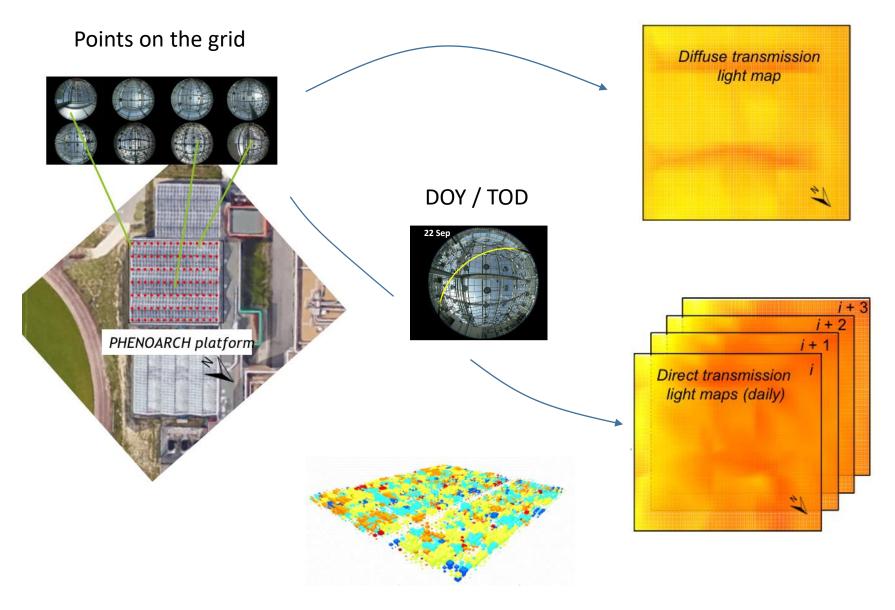
















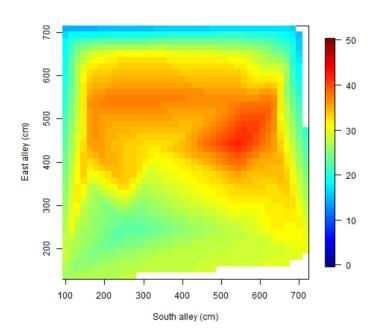


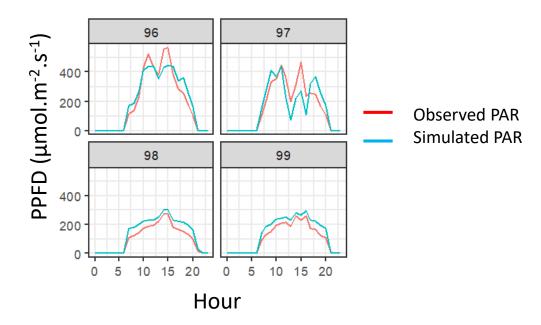












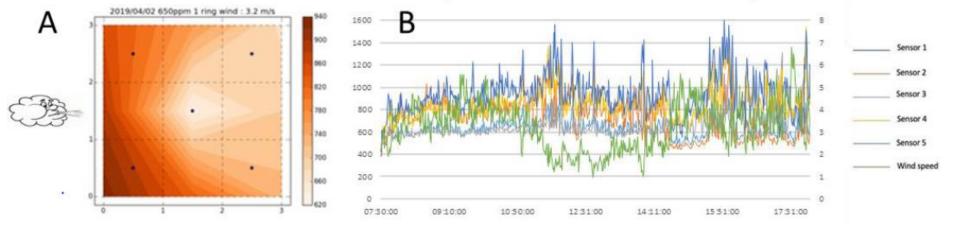












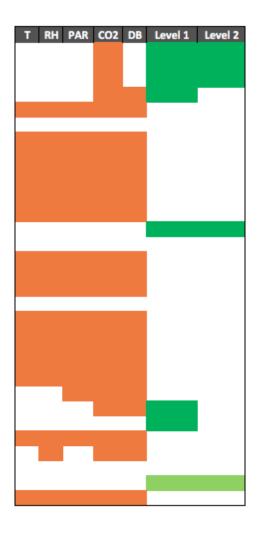




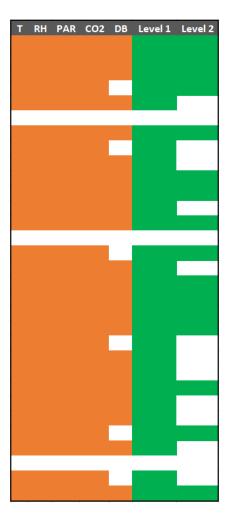




EPPN2020 Kick off meeting



Four years later













Part II – Suitable calibration is a pre-requisite to data fusion from different experiments or PP

Level 1

- 1) Grow a set of plants in the installation
- 2) Measure using imaging procedures (pixels)
- 3) Measure physical traits manually/in lab (cm)
- 4) Establish regression equation of (3) to (2)
- 5) Perform the real experiment (pixels)
- 6) Predict physical variables from (5) using (4)









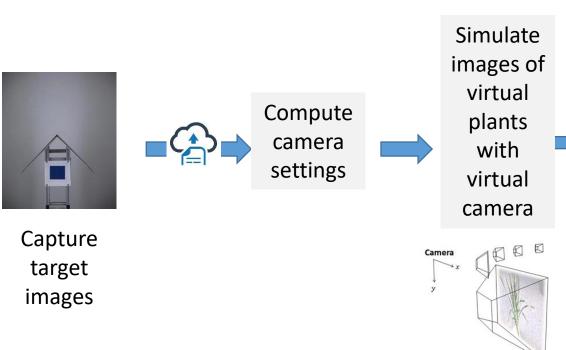




plants!!

An online calibration tool for 2D camera systems

- 1) Grow a set of plants in the installation
- 2) Measure using imaging procedures (pixels)
- 3) Measure physical traits manually/in lab (cm)
- 4) Establish regression equation of (3) to (2)







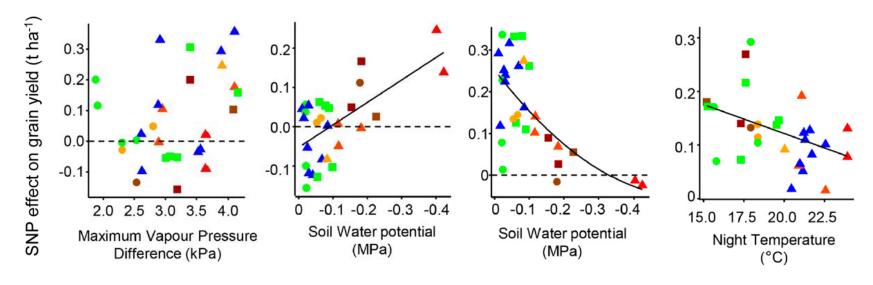






Example of benefits

Improved QTL detection from a network of 29 field experiments following proper calibration of wheather stations and soil sensors + data management + statistics





Plant Physiol. 172-749













EPPN 2020 productions presents

Joint platform experiment \\

Featuring

ABER

4PMI

M₃P

GrowScreenRhizo

IPK

RootPhAir

DIAPHEN

NaPPI

SPPU

MTA

WUR



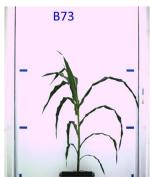






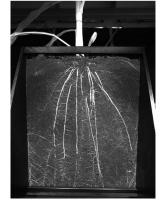


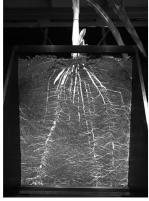
Proper environmental characterisation procedures
Suitable statistical designs
Compatible data management
Common set of (up to) 31 maize genotypes
Complementarity of PP capabilities (root and shoot, GH and field).





VIS, side view





Objectives

Real-life test of joint experiment (whole process)

Design / replication in rhizotron experiments

Dimensionality of root architecture phenotypes

Whole plant integrated analysis of water uptake, transpiration and growth

